THE REPERTORY OF ARTS AND MANUFACTURES:

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SPECIFICATIONS OF PATENT INVENTIONS,

AND

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OF THE

NINTH VOLUME.

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IN THE

NINTH VOLUME.

REPERTORY OF ARTS AND MANUFACTURES.

NUMBER XLIX.

I. *Specification of the Patent granted to Mr.* William Chapman, *of Newcastle-upon-Tyne, Gentleman; for a Method of laying, twisting, or making Ropes or Cordage* *.

WITH FOUR PLATES.

Dated Jan. 12, 1798.

TO all to whom these presents shall come, &c. Now know ye, that in compliance with the said proviso, I the said William Chapman do hereby declare, that my said new-invented method or methods of laying, twisting, or making ropes or cordage, of any number of yarns or strands, or any number of threads, tarred or untarred, from the size of a cable down to the

* This specification (for Scotland) contains the substance of two English patents, one granted September 23, 1797, the other March 6, 1798.

ſmalleſt line compoſed of more than one thread, is deſcribed in the ſeveral plans or drawings hereto annexed; and the following deſcription thereof. It may occaſionally diſpenſe with the uſe of any or all of the following things or apparatus, made uſe of in the common method of laying ropes; that is to ſay, a rope-ground, or ſpace ſufficiently long to ſtretch out the yarn to make the rope or ſtrand of the rope required, in which the yarns, ~~thus extended~~, are twiſted from one or both ends, by hooks to which they are attached, and which, being turned round their axes, twiſt the yarns in the maſs through their whole extent, and form what the rope-makers call a ſtrand; and ſo many of theſe ſtrands as are requiſite to form a rope, which are uſually three, being joined at one end to the ſame hook, and this being turned the contrary way round to what the hooks at that end were before, the three parts are thus twiſted together, and form a rope; which is kept regular in its number of twiſts, proportionate to its diameter and length, by a movable block of wood, called a *top*, with as many grooves in it as there are ſtrands. This top is held from turning round by a croſs bar of iron, or of wood, and prevented from advancing too rapidly by pieces of rope, uſually called *tails*, which are lapped round the rope that is making; and as, by the twiſting of the yarns and of the

rope,

rope, the length becomes ſhorter, the hooks to which the ſtrands are faſtened, (or that to which the rope is faſtened,) being fixed upon an upright frame, on a movable platform, commonly called a *ſledge*, advance forward accordingly.

This is the outline of the proceſs uſually purſued in making what is called a ſhroud-laid rope, each ſtrand of which conſiſts of a number of yarns twiſted together; and if a cable or cable-laid rope is to be made, the common proceſs is, to ſtretch out ſo many ſhroud-laid ropes as there are to be ſtrands in the cable, (uſually three,) and to purſue the ſame manner, in forming them into one rope, as in the preceding inſtance.

In the principal method which I purſue, thoſe parts that ſeparately twiſt the ſtrands and rope (in place of being at the extreme ends of the rope and ſtrands, and approaching each other as the rope ſhortens,) are at any determinate convenient diſtance.

The proceſs of twiſting, conſequently, does not go forward through the whole length at once, but only in the intermediate ſpace; and, in this inſtance, my invention conſiſts in combining with that circumſtance a mode of twiſting the rope or cord itſelf by an arbor or ſhaft, perforated or open, through the whole, or a portion of its extent, and revolving round its own axis; and, at the ſame time, twiſting its ſeveral ſtrands or

parts by ſeparate arbors or ſhafts, either perforated or otherwiſe; each ſhaft revolving round its own axis; and, by the aid of ſuch other machinery as will be deſcribed, performing not ſolely the operation of twiſting the rope or cord, but alſo that of coiling it up by the motion of the machine.

The proceſs of twiſting the rope, and that of coiling it up by the motion of the machine, neceſſarily keep pace with each other, and are performed by the ſame ſhaft; or, the coiling may, when more convenient, receive its motion from any other part of the machine. Each ſtrand occupies another ſhaft, revolving *only* round its own axis, and containing, on one end of it, the yarns or threads, wound upon a reel or reels, or in any other manner.

This relates to the making of ſhroud-laid ropes; and, in the making of cable-laid ropes, the difference conſiſts principally in giving the deſcribed twiſting-ſhafts contrary directions to what they had before, and different proportionate velocities; and in coils of ſhroud-laid rope being ſubſtituted for coils or reels of yarn, for the forming of the ſtrands.

On each of the ſhafts that turn the ſtrands, theſe coils of rope are progreſſively uncoiling; and, at the ſhaft forming the rope, the other end is progreſſively coiling in fakes, or tiers of cable,

on

on a rotative platform; or, otherwife, round a reel moving round with the axis, twifting the rope or cable, but with a diftinct axis of motion; or upon a reel that has the fame axis of motion with the hollow tube or fhaft that twifts the rope; of each of which methods, one example is given in the plans. Befides which, my invention includes, as a principle, every other method of coiling up the rope or cord, or ftrand of a rope or cord, progreffively, as it is made, by any motion from the machine or its moving power.

My invention confifts alfo in making a ftrand or cord, by treating each yarn or thread as a feparate ftrand, in the manner already defcribed; and confequently having as many yarn fhafts as threads, all of which may be turned by a belt.

Left the principles I have defcribed, which admit of confiderable variety in the execution, fhould not be fufficiently plain to enable any mechanic to conftruct a proper machine, I have annexed plans of one of the methods of application, both for fhroud and cable-laid ropes, of which the following is an explanation.

In Fig. 1. (Plate I.) *a*, is a table or platform, with or without, as occafion may require, fo many ftanchions *b*, *b*, as may be neceffary to fupport the requifite number of reels of yarn; each reel turning round its own axis, as in *c*, *c*, in Figs. 1 and 2; and all the yarn concentred at the head

 of

of the shaft. The reels may also be placed in any other convenient manner, according to their number; and, if requisite, may be two or more tiers in height.

Of these tables, there are to be as many as there are designed to be strands in the rope: these tables or platforms I call *strand tables*; and each of them is to be fixed on a hollow shaft, capable of revolving round its own axis; which shaft I call a *strand-shaft* or an *upper-shaft*, and which is shewn by D, in Figs. 1 and 3.

The yarns composing a strand, or, in the case of cables, a strand itself, passes through this shaft, in which there is a transverse opening of sufficient width, which, in its best form, will be rather more than that of the longitudinal orifice. In the transverse opening, *viz.* between *d* and *d*, are to be inserted two blocks, *d* and *d*, (one on each side,) of hard wood, or any other matter, with their opposing faces, as circumstances may require, either longitudinally grooved, or flat, or concave, or otherwise; so as, when forced together by springs, as shewn in Fig. 1, or in any other manner, or by weights, as in Fig. 3, (Plate II.) or by any other means, they may sufficiently resist the passage and twisting of the yarn or strand. These blocks should have their inside-faces rather bevelled towards the upper and lower ends: I call them *press-blocks* or *compressors*. Their use,

ufe, in the making of fhroud-laid ropes, is principally to give a refiftance equal to the ftrefs that would draw the fledge along, in the common method of making ropes; and, in cable-laid ropes, both to retard the paffage of the ftrands, and prevent their turning round, and thus perform the part of the fledge itfelf, in the common method, and of the hook on its face-board, or upright frame.

Thofe purpofes, of holding the ftrand from turning round in the ftrand-fhaft, and giving fufficient refiftance to its paffage through, I occafionally anfwer, by placing in the tranfverfe opening two grooved rollers or fheaves *d*, *d*, Fig. 3, with axes large enough to occafion fufficient friction, and held together in the fame way as the prefs-blocks: thefe I call the *holding-rollers*, becaufe of the office they are to perform. The holding-rollers may either move round their own fixed axes, or upon axes inferted through them, of fufficient diameter to occafion the neceffary friction.

I alfo produce the effect of preventing the yarns from twifting round, in the ftrand-fhafts, by placing within, upon, or below each fhaft, an attached block of wood, or plate of metal, or other fubftance, with a number of notches or grooves round it, or perforated with a number of holes, through each of which, one or any number of yarns may be put: this implement I call a *yarn-guide*.

In

In ſmall ropes, the yarn-guide, the holding-rollers, and preſs-blocks, may be diſpenſed with, and a preſſure applied according to Fig. 10, (Plate IV.) or in any other manner, either upon the yarn itſelf, or upon the rim of the reel; the former being preferable only becauſe it affords an uniform reſiſtance, notwithſtanding the decreaſe of the diameter of the yarn on the reel.

The preſs-blocks and rollers may alſo be diſpenſed with, by a preſſure upon the yarn or ſtrand, at its entrance into the hollow-ſhaft, (or any where in its paſſage to it;) of which one example, out of the variety that may be adopted, is given in Figs. 11 and 12.

In Fig. 11, the yarn is ſtopped from going out too faſt, by a preſſure applied at *u*, which is farther explained by Fig. 12, which ſhews the plan of the table or frame ſupporting the reel or reels. *a*, *a*, *a*, *a*, are the feet of the ſtanchions ſuſtaining the reel. *u*, one ſide of the ſhaft riſing above the platform, over which the threads paſs, as at *u*, in Fig. 11, and are duly compreſſed by the cloſing of the bar *b b*, the forks of which paſs under the ends of *u*, in the opening ſhewn in Fig. 11: this bar is brought to its due preſſure, by connecting it with the end of the ſpring *s s*, and bringing it to its neceſſary degree of tenſion. *n*, ſhews the hole down the ſhaft, through which the threads paſs. If the number of yarns be very

few,

few, or divided into ſeveral parcels, it will be neceſſary to place, between the bar and the part it preſſes againſt, a kind of collar, (round the thread or threads,) of coarſe woollen cloth, leather, felt, or other ſubſtance, which may alſo be applied various ways in the longitudinal grooves of the preſs-blocks, ſo as to occaſion an equable reſiſtance to the yarns in each groove.

Theſe methods may alſo be uſed for as many individual yarns as form a ſtrand; and motion may be given to any number of reels, by a belt round the wheels *g*, *g*, Figs. 10 and 11.

It is perhaps barely neceſſary to ſay, that one preſs-block, or one holding-roller, may be made to anſwer the propoſed end, by making the tranſverſe opening to paſs through only one ſide of the tube in the ſtrand-ſhafts of Figs. 1 and 3; and that the tables or frames containing the reels, &c. may be placed or fixed to any part of the ſtrand-ſhafts, and even on their bottom; in which caſe, theſe ſhafts need neither be perforated, nor open on one ſide, as the ſtrands or yarns would neither have to paſs through or along them, but only to be compreſſed, ſo as to prevent their either twiſting, or paſſing off faſter than requiſite.

The ſtrand-ſhafts all turn uniformly the ſame way with each other, by means of an upright ſhaft C, and wheel 6, communicating with a

wheel *g* on every ſtrand-ſhaft, as deſcribed in Figs. 1 and 3, or by any other means. Theſe ſhafts are placed as cloſe to each other as they conveniently can; and the ſtrands from the ends of each are all concentred to a proper point, and brought to a fixed unrevolving block of wood, or other ſubſtance, of a conic or other form, and with as many grooves, holes, notches, or guides, as ſtrands in the rope, to anſwer the end of the top in the common method of laying ropes, which end alſo may be produced by pulleys, ſheaves, or any other guides.

This block *h*, I call the *laying-block*. Between it and the yarn-guide, the holding-rollers, or the preſs-blocks, (according as they are uſed,) all the ſtrands receive their proper twiſt; and below it (the ſame as between the top and the ſingle hook, in the common method of laying ropes) they unite, and become a complete ſhroud-laid or common rope, by the turning of the ſhaft immediately below the laying-block, *viz.* E, which I call the *rope-ſhaft* or *lower-ſhaft*, and which, by its apparatus, performs the part of the ſingle hook at the end of the rope, in the uſual method.

Between the rope-ſhaft and the laying-block, I occaſionally place a ſhort hollow cylinder of wood, or metal, *viz. i*, of the ſize of the rope to be made; the head of this may be trumpet-mouthed, to receive the lower end of the laying-block.

block. In this cylinder (which, for eafe of placing, may be compofed of two parts) the ftrands firft unite, and become a rope.

The rope-fhaft is perforated, or open in its upper part, and has no prefs-blocks or holding-rollers to retard the progrefs of the rope, but, on the contrary, a pair of fheaves or wheels moving eafily on their axes, to admit the rope a free paffage, and, at the fame time, compel it to twift equally round with the fhaft. Thefe fheaves or wheels, which ought, like the holding-rollers, to be grooved in fuch a manner as to hold the rope from turning fideways, I call the *twifting-fheaves.* Between thefe and the hollow cylinder, I occafionally infert, in the head of the rope-fhaft, hollow tubes of metal, or other fubftance, fuited to the fize of the rope, which I call *gauge-tubes.* When proper gauge-tubes fill up the fpace between the cylinder and the twifting-fheaves, the latter may be forced round, by the action of the rope pufhing from the laying-block, in the fame manner as the top in the common method is forced onwards, notwithftanding the great refiftance made by the tails or tail-ropes. But, in other inftances, thefe twifting-fheaves may receive fuch a progreffive motion as, in every revolution of the rope-fhaft, (which makes one turn of the rope,) the groove of the fheave fhall move fuch a fpace as may be equivalent to the length of rope that is

deſigned to be made by every turn, which will be in proportion to its diameter; and alſo accordingly as the rope is deſigned to have more or leſs twiſt, or, in the uſual phraſe, be long or ſhort laid. A method of performing this will be ſeen by Fig. 3, and is deſcribed in the explanation of the rope-ſhaft of that plan, and its appendages. The rope, from below theſe twiſting-ſheaves, paſſes out ſo far made, and, amongſt other methods, is diſpoſed of in the following ways. If not too unwieldy, I coil it up on a reel, as at *m*, in the rope-ſhaft E of Fig. 1, which is more particularly deſcribed in Figs. 4 and 5, (Plate III.) and in their explanation; where it is ſhewn, that ropes of different ſizes may be made to coil up on the reel, ſo cloſely as to require tying up only, and thus ſuperſede the neceſſity of any farther operation.

For the making of all ropes thus coiled upon a reel, either weights or ſprings may be made uſe of to tighten the twiſting-ſheaves, and the preſs-blocks or holding-rollers; and conſequently the poſition of the ſhafts may be in any direction at will, whether horizontal, vertical, or oblique, the axes all pointing the ſame way, or nearly ſo; the beſt poſition being for the ſtrand-ſhafts to concentre a little towards the head of the rope-ſhaft. The ſtrand-ſhafts and tables may either ſtand round one common centre, as in Fig. 2, which

which will in general be the moſt convenient for ropes; or they may ſtand ſide by ſide, in a right line, or with ſuch a degree of curvature as may accord with the number of ſets that may be moved by one great wheel or belt; which latter mode will be the moſt convenient for ſmall lines and cords, and alſo for ſmall ropes. The ropes that are too large to coil upon a reel, I coil upon a rotative platform, as in Fig. 3. F F, which is fully deſcribed in the explanation of the rope-ſhaft of that figure, and its appendages.

The outlines of making ſhroud-laid ropes being now made apparent, there remains to be ſhewn the proceſs for making cables or ropes of that deſcription. It conſiſts, as above, in ſtrand-ſhafts and a rope-ſhaft; the principal difference being, that they are to move contrary ways to what they did before, and make a ſimilar, or nearly ſimilar, number of revolutions, in place of the conſiderable diſparity of twiſts that are requiſite for the ſtrands of the rope itſelf, when laid as a ſhroud. This diſparity admits of variety, from the cauſes I ſhall afterwards mention; but, for the purpoſe of explanation, I ſhall at preſent aſſume it at two to one in three-ſtrand ropes, (which is nearly the average,) and then the proportionate revolutions of the rope and ſtrand-ſhafts ſhould be three to one, becauſe every revolution of the rope-ſhaft takes out one twiſt from the ſtrands.

If

If the yarns be so hard twisted as to have more than their due proportion of counterbalance to the untwisting tendency of the strands, then the proportionate twists of the rope may generally be less than I have stated; but, if the yarns be unable to resist the untwisting of the strand, or even be twisted the same way as the strand, which frequently is the case in common ropes of a small number of yarns, then the twists of the ropes to those of the strands should be more than I have stated: what they precisely should be, can be no object of this patent; and I only observe, that a small deviation, on either side of the proportionate number of turns of the rope, will be attended with no inconvenience but what will be remedied on its being stretched and used a short time, when it will assume that proportionate twist which will balance the counteracting power of the strand.

From these circumstances it follows, that cable-laid ropes must either be made on separate machinery, or the shafts must assume contrary turns, and different proportions, to what they had before; means of doing which will be described in the explanation of the rope-shaft of Fig. 1.

If the cable-laid rope be small, so that its strands were made upon reels, as at *m*, in the rope shaft of Fig. 1, then these reels, as they come from the rope-shaft, may be fixed upon stanchions,

ſtanchions, as the yarn-reels at *c*, *c*, on the ſtrand-tables of Figs. 1 and 2; or, as muſt be the caſe in large ropes, they may be laid on the upper tables in coils, as at *c*, on the ſtrand-table of Fig. 3, and their ends paſſed through the ſtrand-ſhafts, and united below the laying-block, and brought down between the twiſting ſheaves *n*, *n*: a ſhort piece of rope being then attached to their ends, and brought out of the opening below the ſheaves, and paſſed over the *coiling-wheel p*, and made faſt to the coiling-ſtage F F, ſo as to draw it round, the whole proceſs will go on as deſcribed in the explanation of the rope-ſhaft of Fig. 3.

According to my invention, when the rope is drawn forward by the twiſting-ſheaves, or other means, the top or laying-block and its appendages may be diſpenſed with; becauſe, at ſome given point, according to the proportionate twiſts of the threads or ſtrands to thoſe of the cord or rope, the rope and its ſtrands, or the cord or line and its threads, will balance themſelves. If the ſtrand or yarn ſhafts be ſet ſo as to form a wide angle with the head of the lower-ſhaft, the point of junction will be at the head of that ſhaft; but, if the ſtrand-ſhafts form an acute angle from their feet to the head of the lower-ſhaft, then the point of concentration will be above the head of the latter; and no very material inconvenience

will

will even then arise, provided the pressure retaining the separate strands or threads be quite equal; but, if otherwise, the rope or cord will appear with a strand higher or lower than the rest, accordingly as it may be longer or shorter, by receiving too little or too much resistance in passing from its shaft; which resistance may be regulated, on stopping the machine, by slackening or tightening the springs shewn in the upper shaft of Fig. 1, or by moving inwards or outwards the weights upon the levers, as shewn in the upper-shaft of Fig. 3; and may also, if thought necessary, be regulated, during the going of the machine, by occasional pressure applied on a collar connected with the lever, and capable of sliding up or down any proper part of the shaft.

What I have called shafts, are, under this denomination, principally applicable to the manufacturing of rope; and, when suited to the making of cord, they will be more properly denominated spindles, which of course must be understood through the whole description; and, what I have called upper and lower shafts, will, in the application to cord, be upper and lower spindles.

In the lower-spindles, and even in the lower-shafts for small ropes, there will be no necessity for any part of them being perforated, or open, provided the spindle or shaft be retained in its position, by collars below the reel on which the cord or rope winds up as it is made.

My

My invention likewise consists in making the strands separately, in the following manner: that is to say, I coil or wind up the yarn requisite for a strand on one reel, or any number of reels or bobbins, and fix the reel, or reels or bobbins, on a pin or axis, or pins or axes, round or with which, it or they will revolve, as drawn off. The yarns are then twisted together, and drawn forward by a revolving shaft, similar to E in Fig. 1 or 3, placed in any requisite position, (to which shaft the reels are not fixed:) the yarns are thus made into a strand, which is coiled up, during the process of making, in the modes herein described, or in any other manner, so as to admit of the revolution of the axis or shaft making the strand; which, when thus made, may either be treated similar to a cable-strand, as already described, or it may, with other strands, be laid in a common rope ground, or after the common method, as may also the strands made by any other of my processes, my method being to complete the rope after any of those ways, according to circumstances. In this method, of making the strand by drawing the yarns or threads from off separate reels, that are not fixed to the revolving axis, or shaft that twists the threads together into a strand, I regulate the coming forward, or making of the strand, by apparatus fixed to, or connected with, the shaft, either in a manner similar to

what is explained in the defcription of the fhaft and apparatus for twifting the ftrands into a rope, or in any other way. I alfo place above, or leading to, the head of the fhaft, a yarn-guide, to feparate the yarns to any extent deemed neceffary, likewife to enable them to come off in greater or lefs quantity, as required by the part of the ftrand they fall into. I regulate the refiftance to their coming forward, to any extent wanted to give fufficient compactnefs to the ftrand, and, at the fame time, not prevent the yarns from any reel, or number of reels, from coming forward as required; for this purpofe, that refiftance may either be placed on the reels themfelves, or in any manner that feparates or divides the whole mafs of yarns, or in any other way that allows one or more yarns to flip or come forward independently of the reft.

By the method previoufly defcribed for making a complete rope at one operation, I, during the act of making the ftrands, unite them into a rope, by means of what I there call a rope-fhaft, in which they are all concentred, and receive the twift which forms them into a rope: but I alfo occafionally omit the concentring of them, and the fubfequent part of the operation, during the making of the ftrand or ftrands, and, in place of twifting them into a rope, I only draw the ftrand forward, as made, and coil it or them in any manner whatfoever;

foever; they, in this inſtance, having no rotative motion. The apparatus for drawing forward is not fixed to the revolving-ſhaft, containing the reel or reels, and other neceſſary appendages, but may be permanent, and receive its motion in any proportion whatever to the revolutions or twiſts given to the ſtrand by that ſhaft.

The principles of making the ſtrand in theſe two different ways are obviouſly portions of the proceſs that would, as has been deſcribed, make the whole rope at one operation; and thoſe two methods of making the ſtrand, independently of making the complete rope, are reducible to the following principle; that, in making a ſtrand ſimply, one end only need to be twiſted, and the other held from turning, but that both be permitted to paſs forward, and progreſſively change place; and that the yarns be, if deemed neceſſary, ſo regulated as to come off their reels in ſuch a manner as the part of the ſtrand they come into may require.

There is alſo a third method of making a ſtrand, compounded of the two preceding, which may be followed, *viz.* that of uſing two revolving ſhafts in place of one; the reels being placed on one of them, and the ſtrand coiling upon the other: theſe two ſhafts ought to turn in contrary directions to each other, in place of going the ſame way about, as they do in making the ſtrands and rope at the ſame proceſs.

 The

The making of an individual ſtrand is particularly uſeful, when the rope-machine, explained in Figs. 1 and 2, is not ſufficiently large to make the rope required; under which, or in any other predicament, I occaſionally fix the requiſite number of reels on the ſtrand-tables, ſhewn in Fig. 2, and, paſſing the yarns through the upper-ſhafts, in the ſame manner as if a rope were going to be made, I unite them at the head of the lower-ſhaft E; and then, in place of the fixed laying-block *b*, which is uſed in the making of ropes, I fix a yarn-guide, with any number of grooves or openings, ſuited to the number of yarns, or any diviſion of that number, and then the proceſs goes forward as in the making of a rope, with this difference, that the upper tables ſtand ſtill: this method differing in nothing, from one of thoſe afore-deſcribed, but in the ſaving of the diſtinct apparatus that would be requiſite, to reſiſt the paſſing off of the yarns, and to give the neceſſary hardening or compactneſs to the ſtrand.

Beſides theſe methods of ſeparately making ſtrands in ſuch a manner as to give every yarn, or determinate number of yarns, their fair bearing in the ſtrand, ſo as to give it a degree of ſtrength unattainable by the common proceſs, I have invented a further method, which requires little more apparatus than is uſed in common roperies or laying-grounds, *viz.* at the head of the ropery,

or

or in any other part, I fix, upon pins, so many reels as will contain all the yarns requisite for a strand, or the given number of strands determined to be made at one time, each reel containing one or more yarns; then, in the instance of making three strands, I fix to three different hooks, on the breast or fore-board of a sledge, so many yarns, separately concentring to each other, as are requisite; the yarns being previously passed through the openings of three separate fixed tops or yarn-guides, one opposite to, or correspondent with, each hook. Before, or on the face of each top, towards the sledge, there may or may not be fixed a cylinder, such as I have described below the laying-block at the head of the rope-shaft. The yarns are then to be prevented from passing too easily off their reels, either by a pressure on the reels themselves, or on the yarns, in their passage to, or upon, their separate tops, or in any manner that will permit them to come off as wanted.

The men are then to heave upon, or turn round, the hooks of the sledge in the usual way; and the only remaining difference consists in the sledge being drawn progressively backward, as the strand is making, until the whole, or any determinate length of strand be made. The process of drawing backward may be done various ways; amongst others, by a rope to a capstan, moved either by a horse or men, according to the strength

ſtrength requiſite, which will not be conſiderable, on account of the ſlowneſs of the motion of the ſledge, which, although called technically by this name, I propoſe to move on wheels. The ſtrands being now made, and all joined at one end by a ſingle hook, the wheels of this ſledge may either be locked, and itſelf laden with a proper weight, or it may have attached to it a common ſledge, with its requiſite load, and then the completion of the rope may go forward in the uſual way.

By the deſcribed proceſs of drawing the ſledge backward, and by a ſingle hook on the fore-board of the ſledge, and a fixed top, or any thing equivalent to it, a rope may be made, during the proceſs of making the ſtrands, after that manner which I have deſcribed as admitting the ſtrands to be coiled up in any manner whatever. The other method is, to wind up theſe ſtrands during their making, and afterwards to ſtretch them on the rope-ground, previouſly to the commencement of forming them into a rope, and in this manner one large ſtrand-machine would be ſufficient.

I ſhall here obſerve, that, in place of reels of yarn, I occaſionally ſubſtitute balls of yarn in caniſters, or other veſſels in which they may unwind.

The deſcribed ſhafts, machinery, and apparatus, are not limited to the form or poſition of which

which I have given, or ſhall give, deſcriptions, but obviouſly admit of great variety; and they may receive their motion from ſteam-engines, from water, from wind, or from the power of animals, which may communicate the reſpective direction and velocity to the ſeparate parts, by means of upright and lying ſhafts with cog-wheels, or by belts or chains, or any other methods practiſed by mill-wrights or others; my invention not conſiſting in any particular or limited mode of giving motion to the machine, but in all or any of the following things, *viz.* the application of a fixed unrevolving top or laying-block, of perforated or open ſtrand-ſhafts, and of a rope-ſhaft; and in the uſe of hollow tubes or cylinders at the lower end of the top, and of gauge-tubes; and in uſing preſs-blocks or rollers, and ſheaves or wheels preſſed againſt the ſtrand, or the rope, by weights, or by ſprings, or any thing elaſtic or otherwiſe; the giving any determinate regular motion to the ſtrand, or the rope, or cord or line, ſo as to give it any number of turns that may be deſired in a given length; and in coiling up the ſtrand, rope, cord or line, in any way, during the proceſs of making it, by means of any machinery connected with that employed in making the ſtrand, rope, cord or line, or with its moving-power; alſo in giving the contrary and differently proportioned motion to the ſame machine,

ſo

fo as to adapt it either to fhroud-laid or cable-laid ropes or lines; and in fuch other particulars as will be more clearly defcribed in the following explanations, or have been previoufly noticed, in which I include the placing of more reels or balls than one upon any fingle fhaft, or revolving platform, ufed in the making of the ftrand of a rope.

In fine, my invention goes to the defcribed methods or principles of twifting or laying; and (as a conftituent part in the procefs of making,) that of coiling or winding up ftrands, ropes, and cords or lines.

And I likewife claim, as my invention, the application of rollers, which I call *regulating-rollers*, to the manufacturing of twine made of hemp, flax, or tow, the ufe of which rollers is to give any determinate number of twifts, in any given length of twine; for which purpofe, they are to be intervening between the reels containing the feparate threads of which the twine is compofed; and the fpindles making the twine, which (like the fpindles ufed in the making of thread) muft have belonging to each a flyer and a bobbin, the former twifting, and the latter reeling up, the twine as it is made; which it may do by its refiftance to motion, from the friction of weights drawing or preffing againft it, or other fimilar caufes, and, by the effect of that friction, it

it would draw the threads from off their reels, but it would be in a manner materially irregular, without constant attention in increasing the weights, as the twine increased in thickness on its reel or bobbin. The use of the regulating-rollers therefore is, that the separate threads shall pass from their reels between rollers that have some given determinate motion to any number of turns in the spindle, and consequently be delivered precisely as wanted; for instance, if the twine be to have fifty turns in the length of one foot, then the faces of the rollers, between which the threads pass, must move one foot during fifty revolutions of the spindle; the mode of giving which proportionate velocity is unnecessary to be explained, as being known to every mechanic.

The reels containing the separate threads composing the twine are put upon pins, or other axes, round or with which they separately turn, as required, to unwind. Their position is fixed, and their threads lead off to a conductor or opening, to guide them to the rollers; between which and the spindle, they receive their twist, and are formed into twine. I also claim, as my invention, the use of the regulating-rollers for the manufacturing of worsted, and likewise of cotton, yarns or threads, of any denomination, composed of more than one thread.

Explanation and Defcription of the Coiling-Reel in Figs. 1, 4, and 5.

(See Plate I. and III.)

For ropes not exceeding four inches girt, (or as much more or lefs as may be found convenient,) I propofe the lower fhaft to be as in Fig. 1, where the two fides are fpread out fo as to receive a reel, which may receive its motion in the following manner.

On the end of the axis of one of the twifting fheaves *n*, (Fig. 1.) may be affixed a pulley-wheel *o*, of the fame diameter; which, by means of a belt, may communicate with another pulley-wheel *p*, on the end of the axis of the reel on which the rope is to wind, and of the diameter of the part on which the rope begins to wind; confequently, as the twifting-fheaves move with the fame velocity as the rope is laid, it will be capable of winding it up in the beginning; and, as the rope increafes the thicknefs of the reel, the belt muft flip in the proportion of that increafe; or otherwife the pulley *p*, at the end of the axis of the reel, may be compofed of two concentric wheels; the one fo much lefs than the other, as to afford only a proper degree of friction to lay the rope tight on the reel.

If

If wanted to wind regularly upon the reel, ſo as to ſuperſede the neceſſity of coiling it again, the rope muſt paſs through a collar, as at *a*, Fig. 5; and be guided from ſide to ſide, as each layer is completed, moving the width or diameter of the rope on every revolution of the reel; which may be effected in the following manner, as I ſhall exemplify in the coiling of a four-inch rope.

b c, in Fig. 5, is an iron bar, paſſing through the two ſides of the frame holding the reel of the rope-ſhaft of Fig. 1. The end *b* is ſquare, flat, or angular, and paſſes through a ſuitable hole, to prevent it from turning: the end *c* is a continuous ſcrew, with its threads ſo far diſtant, that one revolution of the nut *d*, Figs. 4 and 5, or ſome proportionate revolution of it, ſhall move the collar *a* the preciſe diameter of the rope; then, if the reel be ſuited to take 12 turns of a four-inch rope on the length of its axis, the following explanation will be ſufficient.

One revolution of the nut *d*, (which contains a female ſcrew,) moving the collar *a* one diameter of the rope, and 12 diameters being equal to the length of the reel, the nut muſt reverſe its motion at every 12 revolutions; then, if the nut *d* have eight teeth, and be in geer with the wheel *e*, of 32 teeth, which is on the ſame arbor with the pinion *i*, the latter will make one revolution, whilſt the nut *d* makes four. The two wheels *f*

and *g* are conſtantly in geer with each other, and turn contrary ways; and, beſides the teeth working into each other, and with the pinion *b*, they have, on the ſame axis with them, two half-wheels, (ſhaded black in the plan,) each of which have 24 teeth, that alternately work into the pinion *i*, of 8 teeth, and thus, giving three revolutions to it, give 12 to the nut *d*, which is the number required. It may be neceſſary to notice, that the wheels termed half-wheels, muſt be ſo much leſs than ſemicircles, as to prevent the poſſibility of both being in contact with the pinion *i* at the ſame time.

From what has been ſaid, it follows, that the wheel *g* only makes one revolution, during the time that the collar *a* moves backwards and forwards, and lays two complete layers of rope on the reel; which, in the preſent inſtance of a four-inch rope, requires 24 revolutions of the reel, which, by the little pinion *l*, on the end of its axis, gives motion to the whole. If this pinion *l* have 16 teeth, and the wheel *k* four times as many, then the pinion *b*, on the ſame arbor, having 8 teeth, and the wheels *g* and *f* 48 teeth each, the latter muſt make only one revolution for 24 of the rope reel, which, in the preſent inſtance, is the number required.

If the rope, in place of four inches girt, ſhould only be three inches and three quarters, then, in place

place of the pinion *l* being of 16 teeth, another of 15 teeth is inserted on the end of the axis of the reel; and thus any rope, down to an inch and a half, or a pinion of 6 teeth, may, by the same machinery, be closely coiled on the reel. In lesser ropes, lighter machinery may be used, and all the proportions of reeling be obtained, in a manner similar to that above described. *m*, is a screw, raising or depressing a collar in which the axis of the reel and the pinion *l* turns; so that, be the diameter of the latter increased or reduced, it may still be in geer with the wheel *k*.

Explanation of the Rope-Shaft of Fig. 3, with its Appendages, &c. Figs. 6, 7, and 8.

(See Plates II, III, and IV.)

E. The rope-shaft.

n n. The twisting-sheaves; one of which (being confined in its position) receives its progressive motion from the endless screw *o*, on the axis of the small wheel *r*, which receives its motion by revolving against a fixed or stationary concave wheel *s s*.

Different velocities may be given to the twisting-sheaves, by having sheaves proportioned to the different ropes, as to the number of teeth in their periphery; having the greater number for the

the ſmaller ropes, and ſcrew-wheels of a correſpondent interval of thread, to fix upon the axis of the wheel *r*. I ſhall exemplify this in the inſtance of a 16-inch cable, which ought, if very hard laid, to come forward a foot, or a little more or leſs, in every revolution, and 16 inches, if rather ſlack laid.

Let the general proportion of the little wheel *r* be $\frac{1}{12}$ of the fixed concave wheel *s s*, which it works within, and the teeth of the twiſting-ſheave as much more than an inch in their pitch, as the extremity of the ſheave is beyond its griping point, then each revolution of the cable-ſhaft muſt lay a foot of rope, and ſo proportionately in all ſmaller ropes, reducing the pitch or ſpace between the teeth accordingly, *viz.* by increaſing their number; and, in ropes of *equal* ſize, decreaſing their number, if deſigned to be ſlacker laid. In the making of ſmall lines or cords, both theſe wheels may be diſpenſed with; as the twiſting-ſheaves may then bear ſuch a proportion to the diameter of the line or cord, that one tooth of that ſheave may be equal to the length of line or cord made by one revolution of the lower ſhaft or ſpindle; and, conſequently, a fixed wheel, containing an endleſs ſcrew of one thread, equal to the ſpace (and vacancy) of a tooth, or to the pitch of the teeth of the ſheave-wheel, will anſwer the purpoſe required. The wheel *s s*, from which the

the twiſting-ſheaves ultimately receive their motion, is not neceſſarily concave, or fixed in this poſition. It may be placed at the foot of the ſhaft; and the axis containing the endleſs ſcrew *o*, may be horizontal, or in any other poſition. The twiſting-ſheaves may alſo, if neceſſary, be each of them driven by a ſeparate ſcrew; or one may drive the other, by a cog-wheel on each: they likewiſe are not confined, either as to the place on the ſhaft, or relative poſition to each other.

FF. The cable ſtage, ſupported on rollers, and cut through, to ſhew the tiers and fakes of the cable.

G. The cable, paſſing out of the ſide of the cable-ſhaft, and over the coiling-wheel *p*, which, by means of the iron ſhank *t*, is drawn in and out, ſo as to lay on the fakes or different turns of the cable, one within or without the other, as it winds in or out, after finiſhing every tier or layer of rope. In this inſtance, the utmoſt diameter of the cable ſtage is 16 feet, and the innermoſt part (of where it is propoſed to coil) 8 feet: this, in a 16-inch cable, will admit of nine fakes in a tier, and the mean length of each fake will be little above 6 fathoms, and of the whole tier about 56 fathoms; conſequently, the coiling-wheel *p* muſt move inwards or outwards four feet in the time (or in leſs time) that 56 fathoms of cable are laying; which, according to the ſtandard

4 of

of hard twifting already affumed, would be done in 336 revolutions of the cable-fhaft; that is, it would move one inch in feven revolutions. Moving inwards or outwards, in lefs time, will be attended with no further inconvenience than leaving a fpace between the fakes, and fooner completing a tier. As the length of the fake increafes or decreafes, the wheel *p* ought to be moved flower or fafter inwards and outwards; but this would be attended with unneceffary complication of machinery, and therefore the medium motion may be fufficient, as it will only occafion the cable to incline a little inwards or outwards.

One mode, out of many, of giving this motion, is as follows: the fhank *t* may be formed as a fcrew, for the neceffary length, and have the fpace of a revolution of thread to be half an inch, and pafs through a nut *u*, containing a female fcrew; then, in the inftance of a 16-inch cable, the nut would have to make two revolutions, in a period not exceeding feven turns of the cable-fhaft, but fay in fix turns; then, let there be two fmall wheels *v v*, Fig. 6, each with an endlefs fcrew *w*, or *x* upon its axis, and the wheels of the fame diameter as the wheel *y*, on the foot of the axis of the wheel *r*, Fig. 3, and connected with the fame wheel *y*, Fig. 6, confequently performing fimilar revolutions. Thefe wheels *v v* muft be on a frame, capable of moving a fhort

a ſhort ſpace in the curved dotted line *w x*, whoſe centre is in the axis of the wheel *y*, therefore never loſing their connection with it; and, accordingly as the ſhank *t* is to move inwards or outwards, the endleſs ſcrew *w*, or the endleſs ſcrew *x*, is to be acting on the nut *u*, which nut is to be ſupplied with different numbers of teeth, and fineneſs of pitch, capable of being eaſily affixed and taken off; as alſo muſt the axes of the wheels *v v* be ſupplied with endleſs ſcrews of correſpondent ſpace of thread. The nut wheel *u*, in the inſtance in queſtion, having to make one revolution in three turns, and the wheel *r* making 36 revolutions in that time, it follows, that the nut-wheel ſhould have 36 teeth. In a cable of half the ſize, to coil it cloſe, it ſhould have twice the number of teeth; but, as no material inconvenience will ariſe from its looſe coiling, the ſame wheels and ſcrews may be diſpenſed with. As to the change of motion, I propoſe to give it in the following, or any other manner, *viz.* that when the coiling-wheel *p* has proceeded to its extremities, either inwards or outwards, its axis *q* ſhall then ſet in motion what in ſteam-engines is uſually called a *ſpanner*; which, being connected with the frame ſupporting the wheels *v v*, ſhall put the ſcrew on the axis of one wheel out of geer with the nut *u*, and throw the other in, ſo as to give the contrary motion. Alſo all, or part, of this

 machinery

machinery may be dispensed with, because, in large cables, the stage will move so slowly that men may stand in it to coil them away, as in a ship's cable-stage.

By means of the rollers, or by wheels affixed to the coiling-stage, it will move sufficiently easy. Some resistance to motion is necessary, that it may recede as the rope advances.

If 60 fathoms of 16-inch cable be made in one hour, the rope-shaft, according to the above premises, need only make 6 revolutions in a minute, and, if not hard twisted, only 5 turns, or as low as 4½.

Smaller ropes, to be laid in the same time, must make a number of revolutions inversely as their sizes.

In Fig. 1, a method of giving motion to the strand-shafts and rope-shaft is shewn, adapted to the contrary and different motions of shroud and cable-laid ropes. In this instance, A, represents (in section) a shaft that may give motion to as many sets of machinery as requisite. 1, is a cogged face-wheel on the lying-shaft, working into the spur-wheel 2; which, by a small movement, must be capable of being disengaged from the wheel 1, and be put into geer with another wheel, (on the same lying-shaft A,) similar to the wheel 1, and with cogs opposite to it, so as to move the spur-wheel 2 the contrary way round.

The

The double bevel-wheel 3, is on the ſame axis with 2, and works on one face into the wheel 4, on the upright ſhaft B; and, on the other face, the oppoſite ſide of the wheel works into the bevel-wheel 5, on the ſhaft C: therefore the ſhafts B and C move the ſame way round.

The wheels 4 and 6, being of equal diameters, and both faces of the wheel 3 being alike, it follows, that the ſhafts B and C muſt move with an equal number of revolutions. As the wheel 6, on the ſhaft C, works into the wheel *g*, at the foot of each ſtrand-ſhaft, and is of the ſame diameter with them; and as the wheel 7, on the ſhaft B, works into the wheel 8, on the rope-ſhaft, and is but $\frac{1}{3}$ of its diameter; it follows, that their revolutions will bear the ſame proportion with each other, as that which has been mentioned to be nearly the medium in ſhroud-laid ropes. Any other proportion, at the option of the manufacturer, may be obtained as eaſily.

To adapt the ſame machinery for making a cable-laid rope, the ſhafts, in the firſt inſtance, muſt all move the contrary way. This is effected by diſengaging the wheel 2 from the wheel 1, and putting it into geer with the oppoſite face-wheel, already deſcribed. The remaining part is, to make the revolutions of the ſtrand-ſhaft and rope-ſhaft equal. This will be obtained by lowering the wheel 7 ſo much, down the ſhaft B, as

to difengage it from the wheel 8, and bring the wheel 9 into geer with 10; which, being of equal diameters, and having the fame proportions to each other as the wheel 6 has to thofe on the foot of each ftrand-fhaft, will confequently give equal revolutions to the ftrand-fhafts and rope-fhaft; which, combined with the contrary motion to what they had, is all that is requifite to form cable-laid ropes with the fame machinery.

In Fig. 3, a cable motion only is fhewn; and the fpur-wheels of the fhafts B and C are only half the diameter of the wheels of the ftrand-fhafts and rope-fhaft that they work into; and they, of courfe, move with revolutions equal to each other, as in the preceding inftance.

If found neceffary to give different proportionate revolutions to the ftrand and rope fhafts, in making fhroud-laid ropes of a greater or lefs number of yarns, the difparity will be trivial; and the effect defired may eafily be produced, by having the wheel 7 to take off, in two or more parts, and fubftituting in its place another wheel, of greater or lefs diameter, which will be brought into geer with the wheel 8, by fhifting the foot of the fhaft B a little inwards or outwards.

Fig. 6, is a horizontal plan, on an enlarged fcale, of the coiling-wheel, with its fupporting rails, and machinery for reverfe of motion, which are fhewn

ſhewn in elevation in Fig. 3. Figs. 7 and 8, are alſo on an enlarged ſcale. The former of them ſhews the above apparatus in elevation, ſimilar to Fig. 3, and the latter is likewiſe in elevation, but tranſverſely to Figs. 3 and 7. The following letters of reference are common to all thoſe figures, ſo far as they are to be found in any of them; *viz.* E, the rope-ſhaft, through which paſſes *t*, the ſhank of the coiling-wheel *p*. *z*, *z*, are the rails on which the coiling-wheel is ſupported, by the trucks or rollers *a* 1, *a* 1. *a* 2, is a forked bar of iron, faſtened at one end by a pin to the bar *a* 3, which moves on a centre at *a* 4, and is charged with a ſufficient weight, at its head, to force the endleſs ſcrew *w* into geer with the nut *u*, when aſſuming its preſent poſition; or to force the ſcrew *x* into geer with *u*, when acquiring the poſition of the dotted line, as at *a* 5. *a* 6, is an upright bar, with a pin through it, to ſupport the bar *a* 2 at ſuch height as that it will not reſt againſt *q*, the axis of the coiling-wheel. I ſhall here obſerve, that the lower limb of the bar *a* 2 may be diſpenſed with. *a* 7 and *a* 8, are moveable ſlides, to be fixed ſo far ſhort of the innermoſt and outermoſt range of the coiling-wheel as nearly the length of the opening in the bar *a* 9, which paſſes over *b* 1, a ſhank connected with the moveable frame of the wheels *v*, *v*.

According

According to the poſition of the bar *a* 3, the coiling-wheel muſt be moving outwards: when *q* arrives at *a* 7, it will carry forward with it the bar *a* 2, until it brings the foot of the bar *a* 3 paſt the perpendicular under the centre *a* 4, and the oppoſite end of the groove on *a* 9 near to the ſhank *b* 1; at which time, the weight on the head of *a* 3, preponderating the contrary way to its former poſition, begins to aſſume that of the dotted line *a* 5, and conſequently carries along with it the ſhank *b* 1; which, diſengaging the endleſs ſcrew *w*, and putting the endleſs ſcrew *x* into geer with the nut *u*, gives the contrary motion required.

Explanation of Fig. 9. (See Plate IV.)

The principle of coiling the rope here is nearly the ſame as in the coiling-ſtage; the reel making ſo many revolutions leſs than the rope-ſhaft as there are coils of the rope upon it; the difference chiefly conſiſts in this mode admitting the ſhafts to be horizontal, if that poſition ſhould be deemed eligible. To enable the rope to be coiled in a ſufficiently ſmall ſpace, it is neceſſary, that either the pulley-wheel *a* ſhould move inwards and outwards, as in the plan for the coiling-ſtage, or that the reel (or wheel on which the rope is to be wound) ſhould change its relative poſition with the

the wheel *a*, by shifting its place on the axis of the rope-shaft; the latter of which may be done various ways, and, amongst others, by the following method; *viz.* the outer rim of the wheel *b b* should move through the notch of a moveable block *c*, that travels backwards and forwards, for a space nearly equal to the length of the axis of the reel. This block *c* should have such a compressure upon the rim of the wheel *b b*, as to be equal to the pulling it round, as the twisting sheaves give out the rope; and it may be moved backwards and forwards by a crank *d*; the crank being rather shorter than half the length of the axis of the coiling-reel, because of its slower motion towards each extreme. The wheel *e*, upon the same arbor with the crank, should move with different velocities, according to the thickness of the rope to be coiled up; which (as it must receive its slow motion by the intervention of other wheels, to which a belt may be applied in the rapid part of the movement) may be done by having drum-wheels of different diameters; and consequently any velocity may be given, proportionate to the size of the rope. This description, even without the aid of the previous examples I have given, is sufficiently plain to any millwright, or person conversant in mechanics, to whom alone a description of mechanical subjects can be made clearly obvious, even with great prolixity.

Ex-

Explanation of Fig. 13. (See Plate IV.)

B, is the tranſverſe ſection of a ſhaft, ſimilar to B in Fig. 1. 6 6, is a ſpur-wheel at the upper end of it, to perform the ſame operation as the wheel 6, on the ſhaft C, in Figs. 1 and 2. This wheel 6 6 is connected with as many wheels *g*, *g*, as may be convenient to place round it; each of them turning a ſtrand-ſhaft D, the ſame as in Figs. 1, 3, and 11.

In the preſent inſtance, the wheel 6 6 is of 6 feet 6 inches diameter, and the wheels *g*, *g*, &c. of 2 feet, making 13 revolutions for four of the ſhaft B; and there are 12 ſtrand-ſhafts, conſequently, applicable to three lower ſhafts, for four ſtrand-ropes, or four ſhafts for three ſtrand-ropes: this plan is drawn to correſpond with the latter. E, repreſents one of the four rope-ſhafts, and 8, the wheel upon it, ſimilar to 8, in Fig 1. 7 7, is a correſpondent wheel, on the lower part of the ſhaft B, and gives motion to all the rope-ſhafts. The diameter of 7 7 is 3 feet 9 ½-inches, and that of the wheels 8 8 is 3 feet 6 inches, *viz.* in the proportion of 13 to 12; conſequently, as the wheels 6 6 and *g g* are as 13 to 4, the ſtrand-ſhafts will make three revolutions to one of the rope-ſhaft. In the ſame manner as deſcribed, any number of machines may be placed round the

the ſame ſhaft or arbor, and any proportionate velocity given to the ſtrand and rope ſhafts.

Alſo, if found neceſſary (which can only be in ropes of a *ſmall number* of threads) to twiſt the yarns, during the proceſs of making a ſtrand, it may be done by a number of ſmall ſhafts, placed as D, D, round the whole, or round a portion of the circle, and giving motion to them by a belt. A reel, with a ſingle yarn may be placed, as in Figs. 10 and 11, on as many of them as there are yarns in the ſtrand; and all theſe, concentring about a top or laying-block, may join at a proper diſtance in one ſhaft, as at B, ſimilar to the rope-ſhaft E, Fig. 1. This ſhaft alſo, like the ſmall ſhafts with ſingle threads, may receive its motion from a belt, and move with the ſame number of revolutions; its uſe (with yarns properly twiſted) being only to prevent the twiſt from being taken out of the yarns, by the contrary twiſting of the rope; which may equally be effected by giving the yarns for ſmall ropes a more than ordinary twiſt.

Description of the Process of Tarring and Warping.

In the methods I have deſcribed, of making ropes, or ſtrands of ropes, where each yarn, or number of yarns, has to take its proper place, it

is neceſſary that every yarn, or ſmall number of yarns, ſhould be ſeparately wound up, and the mode of performing this, becomes an eſſential and conſtituent part of my method or methods of making ropes.

The mode that I have invented is applicable to, and a part of, my method of making tarred ropes. The principle of it conſiſts in winding up ſeparately, during the proceſs of tarring, each individual yarn, or ſmall number of yarns, as may be previouſly determined. In the common method of tarring, which is frequently done to the extent of three or four hundred yarns at one time, they are, as they come from the tar-kettle, paſſed in the maſs through an opening, where they receive ſuch preſſure as to force back the ſuperfluous quantity of tar; and they are drawn forward by the maſs of yarns being paſſed any requiſite number of turns round an axis, which is moved by a horſe, or by any other means; and the whole is progreſſively coiled up. In place of this, my method is, to draw forward, and wind up, any determinate number of yarns, by their ends being faſtened to their reſpective reels, one or more to each; and, as it is neceſſary to keep the yarns from entangling, in their paſſage from the tar-kettle, or other veſſel, to their reels, I occaſionally preſs them ſeparately, in ſuch a manner as that each reel ſhall draw forward its own yarn or

yarns,

yarns, independently of the reſt, ſimilar to what I have deſcribed in the paſſage of the yarns through the ſtrand-ſhaft; which may be done by one general preſſure, the yarns being divided in layers, by the intervention of coarſe woollen cloth, felt, or any other elaſtic or pliable ſubſtance, and in the tranſverſe direction to thoſe layers: they may be farther ſeparated by the inſertion or intervention of metal or wooden pins, or other diviſions, which muſt have correſpondent openings or grooves, either in the preſs-block, or place preſſed againſt. It is only neceſſary farther to obſerve, that not any of the reels on which the white yarns are wound, and from which they unwind as they paſs into the tar-kettle, ſhould paſs its yarns to two or more reels, as inconveniencies would thereby ariſe in regulating their manner of winding up; conſequently, the white yarn ſhould be on as many ſeparate reels as the tarred yarn is propoſed to paſs on to at the ſame time. By theſe means, during the proceſs of tarring, any requiſite length of tarred yarn may be wound up, and cut off, and other reels may be ſubſtituted for the continuation of the proceſs, for the reſidue of the yarn. In the paſſage of the yarns through the tar, it will be eligible to keep them ſeparate, by paſſing them through diſtinct openings in the piece of metal uſually called by ropers a *foot*; one or more of which is ſometimes uſed

to keep the yarn under the furface of the tar, in its paffage through the kettle. According to this method, much of the trouble requifite in warping, or laying out the defired length and number of yarns for making a ftrand of a rope, will be faved.

Observations on the Scale of the Plans, &c.

The figures themfelves are not meant to give any decidedly fixed, or relative proportions of the different parts of each machine; but, as they may be carried into execution on the dimenfions that are delineated, I fhall obferve, that all the figures, excepting 4, 5, 6, 7, and 8, are drawn on a fcale of $\frac{1}{6}$ of an inch to a foot; and the figures laft mentioned on a fcale of half an inch to a foot.

It muft likewife be noticed, that the teeth or cogs on the wheels are, in fome parts, omitted; the defcription and figures combined being deemed fufficiently explanatory without them. In Witnefs thereof, &c.

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Fig.1.

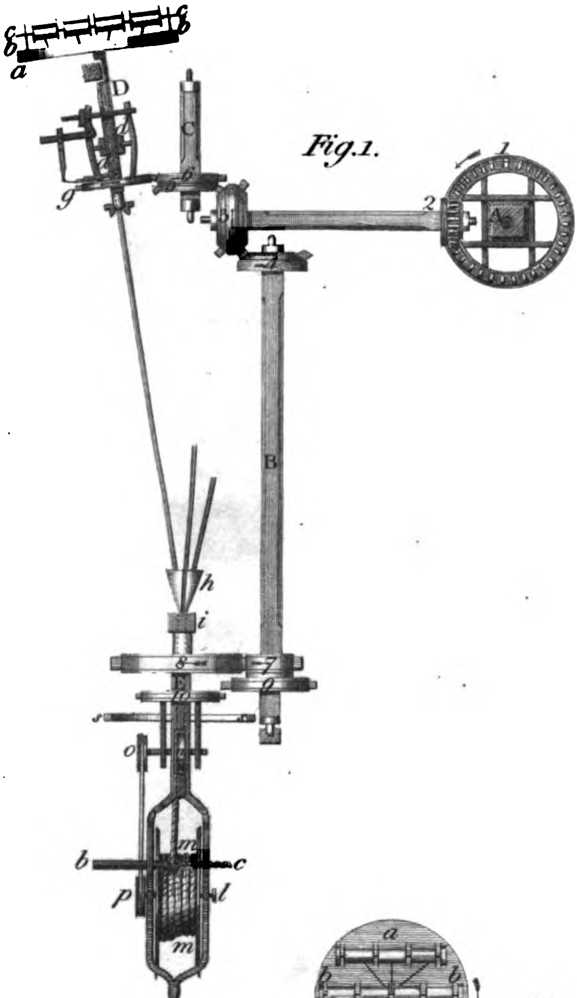
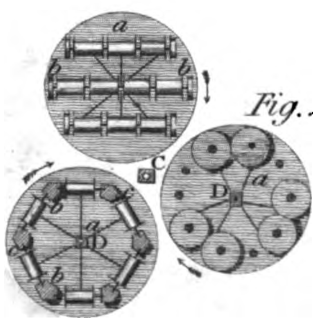


Fig. 2.



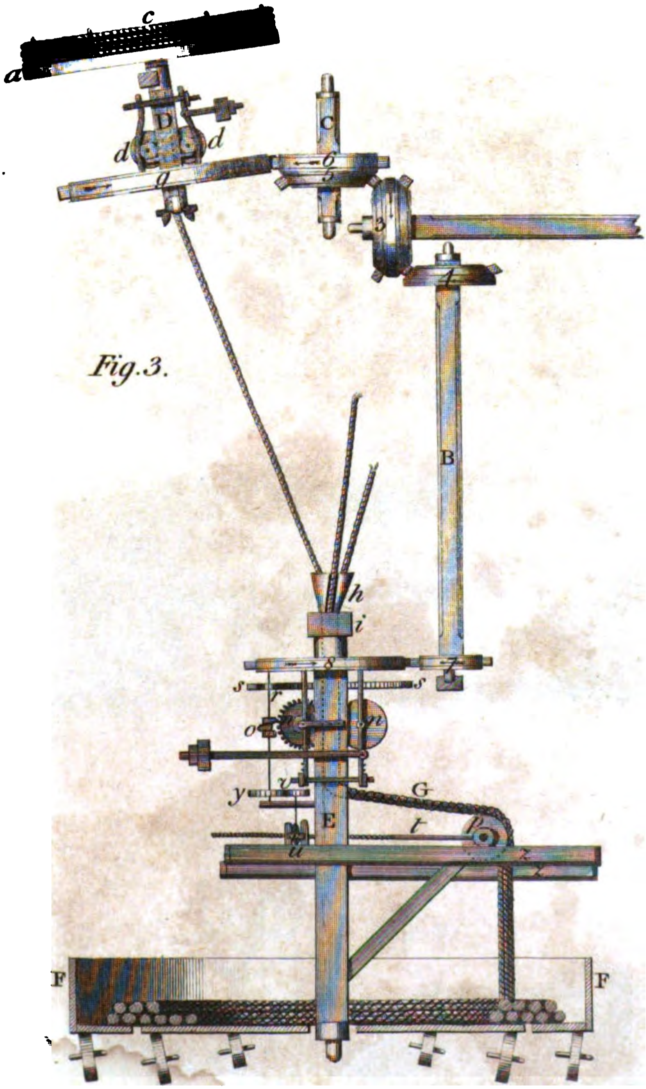


Fig. 3.

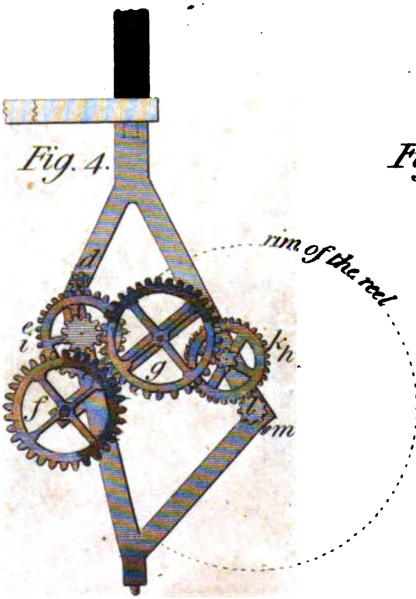


Fig. 4.

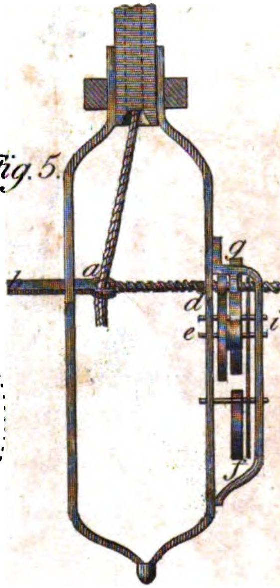
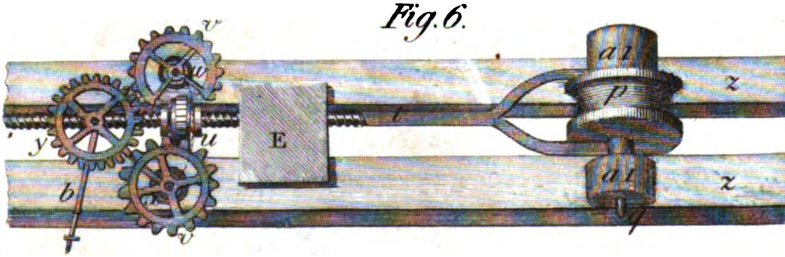


Fig. 5.

Fig. 6.



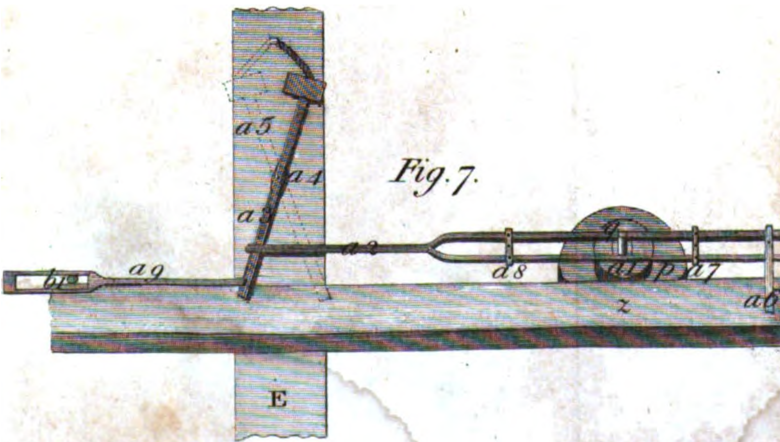


Fig. 7.

Fig. 8.

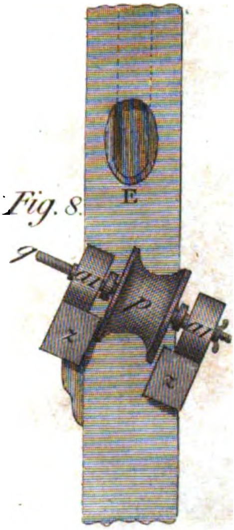


Fig. 9.

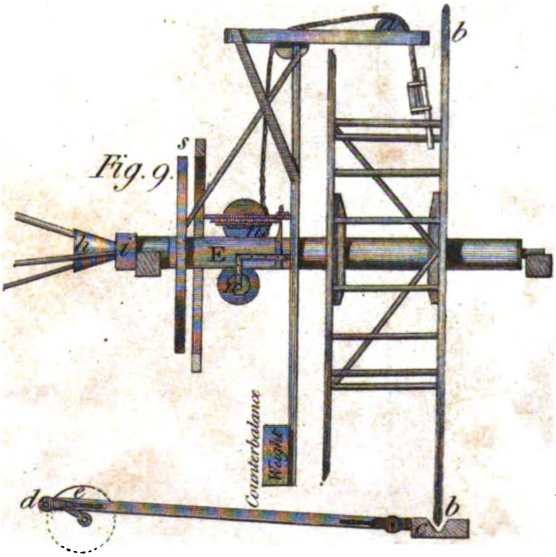


Fig. 10.

Fig. 11.

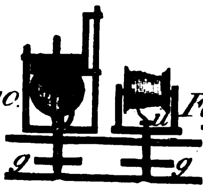
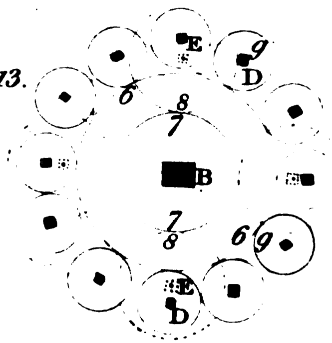


Fig. 12.

Fig. 13.



II. *Specification of the Patent granted to Mr.* JOHN HOWELL, *of the Parish of Ofwestry, in the County of Salop, Coal-master; for an improved Engine or Machine for the Purpose of boring or hollowing wooden Water-Pipes or Aqueducts, in a much more expeditious Manner than hitherto practised, and whereby a considerable Saving will be made in the Article of Timber.*

Dated May 31, 1796.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said John Howell do hereby declare, that my said invention is described in manner following; that is to say, instead of the common method of boring by augres, or instruments of any other description which perforate the wood by cutting out the inner part of the substance in chips or shavings, a hollow tube or cylinder, made of thin plates of iron, or other metal, about one inch less in diameter than the hole to be bored, is to be made use of. To one end of this tube or cylinder is to be fixed a flanch or

ring,

ring, of from one quarter of an inch to five eighths of an inch in breadth; and one part of the circumference of this flanch or ring is to be divided or ſeparated, ſo that, if it be made of ſteel, an edge or cutter may be formed thereby; or, for the more convenient uſe of it, a cutter of ſteel, or other metal, may be ſcrewed, or otherwiſe connected with the tube and the flanch or ring. The operation of this inſtrument is, that it will bore out of a piece of wood, whilſt forming it into a pipe, a ſolid piece of wood, capable of being converted into a pipe or pipes of leſs dimenſions; and that it will do this with the aid of leſs power, and at leſs expence, and with leſs waſte of wood, than by means of the boring inſtruments now in uſe. In witneſs whereof, &c.

III.

III. *Specification of the Patent granted to Mr.* William Bell, *of Walsall, in the County of Stafford, Engineer; for a Method of making Needles, Bodkins, Fish-Hooks, Knitting-Pins, Netting-Needles, and Sail-Needles.*

Dated Sept. 8, 1795.

To all to whom these presents shall come, &c. Now know ye, that in compliance with the said proviso, I the said William Bell do hereby declare, that the method by which I make needles, bodkins, fish-hooks, knitting-pins, netting-needles, and sail-needles, is by casting them with steel or common fusible iron, called pig or cast iron, into moulds or flasks made with fine sand. Or otherwise I make stocks or moulds of iron or steel, or any other composition capable of being made into moulds; on which stocks or moulds I sink, engrave, or stamp, impressions of the said articles. Into those I pour my melted iron or steel, (I prefer, for my purpose, sand-casting,) and prepare my iron or steel as follows. I melt it in a pot or crucible, in small quantities, about the weight of twelve

twelve pounds, (and upwards to twenty pounds,) the more conveniently to diveſt it of its heterogeneous particles, and to purify it from its earthy or ſulphureous qualities. When the iron has attained a proper heat, I take charcoal duſt, mixed with lime, or common ſalt, which I throw into the pot of melted iron; and, by frequently ſtirring it with an iron rod, I bring to the ſurface of the iron a ſcoria, which I frequently ſkim off, and thus bring my iron into a refined ſtate. I then pour it into the mould before deſcribed. The articles being thus formed, are capable of being ſoftened, hardened, or tempered, in the uſual way by which needles, bodkins, fiſh-hooks, knitting-pins, netting-needles, and ſail-needles, have heretofore been manufactured; therefore, the principal merit of my invention is in caſting them, inſtead of making them in the uſual way. In witneſs whereof, &c.

IV.

IV. *Account of an Experiment to ascertain the Quantity of Butter and Cheese producible from a given Quantity of Milk. By Mr.* JOSEPH WIMPEY, *of North-Bockhampton.*

From the Letters and Papers of the Bath and West-of-England Society for the Encouragement of Agriculture, &c.

AS experiments to determine the comparative value of butter and cheese have been thought of some importance, I take the liberty of presenting one to the society: it is on a small scale, but made with great care and exactness.

One hundred and five gallons and a half of milk were properly disposed in pans for skimming off the cream. It produced thirty-six pounds of butter, and sixty pounds of skimmed cheese. The low average of good butter, in this neighbourhood, is 8½*d. per* pound: and the skimmed cheese was sold for 2*d. per* pound. I am informed that this sort of cheese, three or at most four years since,

 sold

ſold only for a penny farthing, or at moſt three halfpence, *per* pound.

	£.	s.	d.
36lb. of butter, at 8½*d.* -	1	5	6
60lb. of ſkimmed cheeſe, at 2*d.*	0	10	0
Total, -	1	15	6

Of a like quantity of milk, namely, one hundred and five gallons and a half, were made one hundred and ſix pounds of raw-milk cheeſe, and ſix pounds of whey-butter. The cheeſe, at two months old, was worth at leaſt 3½*d.* *per* pound, and the whey-butter ſold at 7*d.* *per* pound.

	£.	s.	d.
106lb. of raw-milk cheeſe, at 3½*d.*	1	10	11
6lb. of whey-butter, at 7*d.* -	0	3	6
Total, -	1	14	5

From this experiment it appears, that when the butter and cheeſe, of each ſort above mentioned,

tioned, will ſell for the above prices, a ſmall advantage lies on the ſide of butter and ſkimmed-cheeſe. It amounts to 13*d.* only in £.1. 15*s.* 6*d.* which is about three *per cent.*

Butter from half new milk and half whey, would be of a middle quality between the other two, and the coſt-price of courſe muſt be ſo too, and ſo muſt cheeſe from half-ſkimmed milk: each of theſe may be varied in goodneſs, according to the proportion of milk and whey, and of the milk ſkimmed and unſkimmed; ſo that the price of the latter may be varied from 20*s.* to 30*s.* *per* hundred. But the advantage of following either courſe depends upon local circumſtances, as was obſerved before; and the dairyman, to acquire the greateſt profit, muſt regulate his mode of practice accordingly.

V. *Account of an Improvement made in the Mercurial-Level invented by* ALEXANDER KEITH, *Esquire, F. R. S. and A. S. Edinb.* * *By the Inventor.*

From the TRANSACTIONS of the ROYAL SOCIETY OF EDINBURGH.

THIS improvement confifts in a contrivance for avoiding the trouble of pouring the mercury out and into the level, every time it is ufed. Befides the canal of communication at the bottom, between the two upright columns of mercury, on which the floats fwim, (fee Vol. III. Plate XIX.) there is, in the new manner of conftructing the inftrument, another canal, parallel to the former, cut in the upper part of the wood, which allows the air to circulate freely, according as the mercury below rifes or falls. The

* A defcription and figure of this level is given in our third volume, page 338.

whole

whole is made perfectly close, so that no more air can get admittance.

The instrument may be carried about, when constructed in this manner, with the mercury remaining in it; and though, by agitation, that fluid calcines, and is converted into a grey powder, this only happens when it has free access to vital air; but, as all such access is here prevented, the mercury will not lose its metallic lustre.

The level, in this form of it, as it requires no previous adjustment, is very commodious; and, when much accuracy is not required, may be used with advantage.

VI.

VI. *Conjectures relative to the Cause of the Increase of Weight acquired by some heated Bodies, during cooling. By* THOMAS HENRY, *Junior.*

From the MEMOIRS of the LITERARY and PHILOSOPHICAL SOCIETY of MANCHESTER.

MANY experiments have been made, by different persons, with a view to determine, whether the addition of actual heat to bodies does increase their weight. M. Buffon has asserted, that a ball of iron, weighing when cold 49 lb. 11 oz. increased in weight, when made of a white-heat, in the proportion of $19\frac{1}{5}$ grains to every pound. But it is very probable, that in this experiment there was some fallacy, since we find it directly contradictory to the results of the experiments made by Dr. Roebuck *, and of those made by Mr. Whitehurst †. The first of these two gen-

* Phil. Transf. Vol. LXVI. page 509.
† Ibid. page 575.

tlemen

tlemen found, that a cylinder of wrought-iron, heated to a welding heat, at which time it weighed, in a very accurate balance, fifty-five pounds, gradually acquired, as it cooled, an increaſe of weight; ſo that, at the end of twenty-two hours, it weighed ſix penny-weights ſeventeen grains more than it did when firſt committed to the balance. This phænomenon, which by ſome has been adduced to prove that heat is the principle of levity in bodies, Mr. Whitehurſt has endeavoured to explain, by ſuppoſing that, the air above the ſcale being rarefied by the heated iron, the cold air below ruſhed up, and, ſtriking againſt the bottom of the ſcale, not only prevented its deſcent, but even buoyed it up. Something may, perhaps, be attributed to this cauſe; but would not the circumambient air beneath the ſcale be nearly as much rarefied as that above? And, is it not probable, that the ſuppoſed force of this current of air would be in great meaſure counteracted, by the greater tendency a body has to deſcend in a rarefied, than in a denſe medium? Is it not probable, likewiſe, that the end of the beam, to which the heated iron was appended, would, by the ſame heat which rarefied the air, be more expanded, and lengthened, owing to its nearer approximation to the ſource from which the heat flowed, than the more diſtant end of the beam?

beam? I would likewife obferve, that in the experiment of M. Buffon, above quoted, and in one made by Dr. Roebuck, on a fmaller fcale, the mafs, owing perhaps to the joint action of the above caufes, weighed more when hot than when cold.

Having thus endeavoured to fhew the infufficiency of the explanation given by Mr. Whitehurft, I will venture, with the greateft diffidence, to propofe the following query. May not the increafe of weight acquired by heated iron and copper, during cooling, be afcribed to the calcination and confequent abforption of air, continuing to proceed after the removal of the mafs of metal from the fire, the abforption of air in particular, in the firft ftages of cooling, perhaps with increafed rapidity? In fupport of this conjecture, the following facts may be adduced: Firft, that fome metals, particularly copper *, are found to calcine more rapidly in a moderate degree of heat, than in one more intenfe. Secondly, that the calces of fome metals, as that of lead, have been obferved to increafe in weight by long expofure to the air; and that they then afford, by proper treatment, more air than could have been obtained from them, previous to fuch

* Macquer's Inft. of Chemiftry, Vol. I.

expofure.

exposure. Thirdly, we shall find, by examining Dr. Roebuck's account of his experiments, that the weight continued to increase, long after the cause assigned by Mr. Whitehurst must have ceased to act. The cylinder, which was repeatedly weighed at intervals, when it had been in the scale six hours, and had then lost so much of its heat as to be only blood-warm, was found to be acquiring weight, in the proportion of seven grains in the space of an hour *. But, when weighed the day following, at the expiration of twenty-four hours after the commencement of the experiment, it had acquired a still farther addition, of two penny-weights and seventeen grains, which, according to the above progression, it would have required at least nine hours and a half, nay most probably even a longer time, to accomplish. If to these nine hours and a half we add the preceding six, we obtain fifteen hours and a half; a period, long before the expiration of which, the mass of iron must have taken the temperature of the surrounding bodies, since the

* During the two first hours of its exposure in the scale, the increase of weight had proceeded with much more rapidity: in the third hour, it proceeded less quickly, and continued to diminish gradually in celerity, to the expiration of the sixth.

first fix of these were sufficient to reduce it from the welding point down to blood-heat.

I shall conclude by observing, that metals, which are the only bodies hitherto employed to determine this point, are certainly, from the changes they undergo by the action of heat, very ill-adapted to the purpose; and that, to arrive at any degree of certainty, it will perhaps be necessary to weigh the body *in vacuo*, or at least in a vessel so confined as that any current of air through it shall be prevented; also, that the beam of the scales shall be formed of materials less liable to expansion by heat, than metals in general are.

VII.

VII. *Account of a Method of fixing Mercury.* By Dominick Vandelli, *Professor of Natural History and Chemistry, in the University of Coimbra.*

From the Memoirs of the Royal Academy of Sciences of Lisbon.

BY causing the vapour of mercury to pass through a tube of iron, full of nails, and red-hot, I obtained (attached to the nails) globules of mercury, which had the colour of silver, and the consistence of tin.

We think it necessary to inform our readers, that the *whole* of the original paper is here translated, lest they should suppose it impossible that so curious a discovery as a method of fixing mercury (otherwise than by cold) should be announced, by a professor of chemistry, in so very crude and unsatisfactory a manner. No mention is made of any means used to ascertain the purity of the mercury made use of; nor is it said that any experiments were afterwards made upon the globules of metal, to determine whether they were really mercury or not. From these circumstances, and indeed from the general tenour of the experiment, we think our chemical readers will be strongly inclined to suspect, that the metallic globules here spoken of, consisted merely of lead, or tin, with which the mercury was adulterated.

VIII. *On the Composition of Writing-Ink. By M.* Ribaucourt, *Member of the Academy of Sciences of Rouen, &c.*

FROM THE *ANNALES DE CHIMIE.*

THERE are few chemical preparations, perhaps none, of which the benefit in civil life is so great, or of which the use is so widely extended, as that of common writing ink; consequently, there is no preparation the quality of which it is more necessary to enquire into, yet there is perhaps none which has been more neglected by chemists. Before Lewis, no author appears to have particularly applied himself to enquire into the theory of this composition, and to endeavour to bring it to perfection. All that is to be found in the works of a small number of other writers consists merely in some *formulæ* for making ink, which, being composed without any attention to chemical principles, are more or less defective; so that it may be truly said, that, until the time of Lewis, the preparation of this liquor, the properties of which it is so essential to attend to, was left entirely to chance.

It

It is indeed true, that fome good kinds of ink have been difcovered by chance; but thofe who difcovered them have kept their compofition a fecret, fo that the public were obliged either to purchafe thofe inks of the inventors, or to make ufe of fuch as were inferior in quality, and more or lefs perifhable. As the theory of this liquor was very little known, there has been, till now, no bafis upon which any principles for preparing it in a more fixed and certain manner could be eftablifhed.

The fmall number of authors who have, in a curfory manner, faid any thing refpecting ink, have confounded it with the black dye for cloths, &c. becaufe the bafis of one was fimilar to that of the other. But I muft obferve, with Lewis, that although the ingredients which enter into the compofition of ink are in part the fame as thofe of the black dye, there is however fome difference in the proportions, &c. Many of thefe mixtures, which are too perifhable, when fuperficially applied upon paper, are fufficiently permanent, when introduced into wool; and other mixtures, which produce a good black upon paper, give only a brown colour when employed in dying.

I may add to this obfervation, that not only the proportions, &c. vary, but likewife, that though the bafes are the fame, the other ingredients are not fo; for it is poffible, as fome authors have obferved,

observed, (particularly M. Berthollet,) to dye black, by substituting oak-bark, sumach, and many other vegetable astringents, in the place of galls. But these substances, although they produce a fine black colour when used in dying, cannot be used for making ink; which liquor cannot be made to have a beautiful and durable colour, without the assistance of galls. There is, consequently, a great difference between the liquor used for dying black and ink.

On the Ingredients commonly used in the Composition of Ink.

Galls and sulphate of iron (green vitriol) always form the basis of ink: gum-arabick also generally enters the composition.

Some authors add sugarcandy thereto; others reject it.

Lewis adds logwood to the composition.

Some persons add sulphate of copper (blue vitriol) to it; others add verdegris.

Geoffroy makes use of alum.

Lastly, according to Lewis's account, many persons substitute sulphate of copper, or of zinc, (white vitriol,) in place of the sulphate of iron.

With

With reſpect to the liquid made uſe of, diſtilled water, rain water, or common water, are, according to Lewis, equally good; ſome perſons, however, make uſe of beer, others of white-wine, and others of vinegar.

It appears, therefore, that there is a great difference between authors, reſpecting the ingredients which ought to enter into the compoſition of ink, and that they agree only in making uſe of galls; that being the only ingredient which enters univerſally into every *formula*. This difference can only proceed from the want of a common theory, reſpecting the nature and properties of theſe ingredients, and of their manner of acting upon each other, particularly of the ſulphate of iron and galls.

I ſhall not treat of the natural hiſtory of the ſubſtances which enter into the compoſition of ink; nor ſhall I give the chemical analyſis of any of them, (except galls,) both one and the other being ſo well known, that I could only repeat what other authors have ſaid. I ſhall therefore confine my obſervations to the examination of thoſe ſubſtances which contribute, either to the blackneſs of this liquor, or to its conſiſtence, or to its permanence; qualities which, when united, conſtitute its perfection.

Analyſis

Analysis of Galls.

All the analytical experiments I am now about to describe; and likewise what relates to the reciprocal action of galls and sulphate of iron, are extracted from a paper I wrote in the year 1782; which paper I sent to the Academy of Sciences of Rouen, in 1791. I always operated upon Aleppo galls; that being the sort which ought always to be chosen, in preference to any other, if it be wished to obtain the best ink possible.

Galls, when distilled with water, at the mean temperature of boiling water, produced a liquor which gave a purple colour to a solution of sulphate of iron.

Eleven ounces of galls, put into a retort, placed in a reverberatory furnace, produced, first, an insipid phlegm, the first portions of which gave a purple colour to a solution of sulphate of iron; and afterwards a small quantity of phlegm, which was slightly acid. I did not weigh these two quantities of phlegm; they were followed by two ounces and three drachms of an acid empyreumatic spirit, mixed with oil.

A solution of potash, poured upon a strong decoction of three ounces of galls, precipitated from it nine drachms of a grey earth, which was soluble, with effervescence, in acids.

The

The filtered liquor was rather turbid. A small quantity of a solution of potash, being again poured in, gave it a dark-green colour, and precipitated from it a small quantity of a brown matter. The filtered liquor was transparent, and had a fine green colour.

This last liquor was evaporated to dryness; its residuum, after being calcined in a crucible, furnished, by lixiviation and evaporation, some very white sulphate of potash.

These products, from the analysis of galls, shew that the principle which gives a black colour to iron is volatile, since it rises in distillation, with the mean heat of boiling water.

We are also shewn thereby, that galls contain all the principles of which vegetables usually consist.

But what we particularly remark in this analysis, and which serves to explain the phænomena which galls present with sulphate of iron, is, that they give three drachms *per* ounce, of an earth similar to the absorbent earths; and that this earth is held in solution by an acid, or is in the state of a salt with an earthy basis, since it is precipitated by the action of potash.

The sulphate of potash, which was furnished by the saturated decoction of galls, shews that galls contain a certain portion of sulphuric acid; and the green colour which that decoction re-

 tains,

tains, after the precipitation of the earth, shews that it contains iron.

I was surprised that I obtained only a small quantity of sulphate of potash; very inferior to that of the acid indicated by the quantity of precipitated earth. I supposed that the salt, formed by the combination of the acid of the galls with potash, had been volatilized during the calcination. The experiments of Scheele upon this subject, which were not then known, have since justified my conjecture.

I do not know that any person before me, or indeed hitherto, has discovered the forementioned earthy salt in galls. This discovery has afforded me a clue to the theory of ink; in which we shall see that this salt acts the principal part.

I am also ignorant whether, until the publication of my experiments, it was known that sulphuric acid exists in galls.

The decoction of galls gave me, by evaporation, an extract, which had nothing particular in its appearance: I only observed, after having let it dry in the air, a great number of small saline crystals, in the form of needles, which I considered as the salt resulting from the union of the vegetable acid of the galls with potash. I tried in vain, by all known means, to obtain these crystals free from the extractive matter with which they were mixed.

Two

Two ounces of galls gave me one ounce and three drachms of extract, of the usual consistence; which, after being thoroughly dried in the air, was found to be reduced to one ounce and twenty-four grains.

On the Action of Galls upon Sulphate of Iron.

I shall not repeat what has been already said, respecting the various changes of colour resulting from the union of these two substances, or respecting many other circumstances now generally known; nor shall I examine any of the systems which have been formed upon the subject; but shall only give an account of my own experiments, and deduce such consequences as appear to me naturally to result from them.

I poured a solution of one pound of sulphate of iron into a strong decoction of one pound of galls; I diluted the mixture with such a quantity of water, that the whole amounted to forty pounds; I then let it stand undisturbed.

After twenty-four hours, the liquor had acquired a very dark and blackish purple colour. I poured it off, and found at the bottom of the vessel a very coarse precipitate, which felt rough to the touch. I collected it upon a filter, and,

when dry, it was of a greyish blue colour, very compact, and brittle; its broken surface had a shining appearance. It weighed eleven ounces and a half.

I poured forty pounds of water into the liquor which I had decanted, and let it stand for twenty-four hours.

At the expiration of that time, I found the colour of the liquor much lighter than at first; a fresh precipitation had taken place, which I separated as I had done the former. It appeared to be less heavy than the preceding, and was of a purplish blue colour, when dry. It was loose and friable between the fingers, and appeared granulated and dull, when broken. It weighed four ounces and a quarter.

I again added forty pounds of water to the decanted liquor; and, after twenty-four hours, found that it had completely lost its colour. It did not appear that it contained iron, when tried with galls, or with Prussian acid; nor that it contained earth, when tried with potash. It had deposited a small quantity of precipitate, which was light and loose, and of a bluish colour; less inclining to purple, and more inclining to black, than the preceding. It was more soft to the touch while yet wet, and more light and friable when dry. It weighed two ounces and a quarter.

I should

I should have been very much embarrassed to account for this successive precipitation, which took place every time I diluted the mixture of galls and sulphate of iron with water, if I had not had the example of what happens in the decomposition of alum by water, of which I have given an account to the Academy of Sciences, &c. of Rouen *. I therefore supposed, that a very large quantity of water would decompose metallic salts, in the same manner as it decomposes alum; and it will be seen, that I afterwards verified this conjecture, with respect to sulphate of iron. But, first, I resolved to repeat my experiment, and to see whether, by diluting the mixture with a sufficient quantity of water at once, I could not succeed in entirely depriving the liquor of colour, and precipitate from it all the selenite, and all the oxide of iron, (charged with all the extractive colouring part of the galls,) by one operation, as I had before done by three.

For this purpose, I poured a solution of two ounces of sulphate of iron, into a strong decoc-

* If, to a very clear and limpid solution of alum in water, a great quantity of fresh water be added, the mixture will grow turbid, and, if a sufficient quantity of water be employed, the alum will be completely decomposed, and all its earth will be precipitated. I found that ninety-five parts of water were necessary to decompose, in this manner, one part of alum.

tion

tion of two ounces of galls, and I diluted the mixture with such a proportion of water, as made the whole quantity of liquor amount to sixty pounds.

After the liquor had stood twenty-four hours, it had completely lost all colour, and gave no sign that it contained either oxide of iron, or selenite. I decanted it, and collected the precipitate upon a filter: it was of a blackish blue colour; and, after being dried, weighed two ounces and a quarter.

I must again repeat, that I consider the discovery of the phænomena which these two substances present, as a circumstance which serves to explain the action of galls upon sulphate of iron, and the theory of making ink, as well as that of dying black; and, although I do not mean to treat particularly on the latter subject, I cannot help making, as briefly as possible, the following observations upon it.

TO BE CONTINUED IN OUR NEXT.

IX.

IX. *List of Patents for Inventions, &c.*

(Continued from Vol. VIII, Page 432.)

Andrew Cederbarg, of St. John's-lane, Clerkenwell, in the county of Middlesex, Engine and Mathematical Instrument maker; for a machine or instrument for the purpose of glazing, polishing, and graining divers sorts of leather, &c. Dated February 28, 1798.

William Chapman, of Newcastle-upon-Tyne, Gentleman; for a method of laying, twisting, or making ropes or cordage, of any number of yarns or strands, or any number of threads, tarred or untarred. Dated March 6, 1798.

Henry Goolding, of Willesden, in the county of Middlesex, Yeoman; for a machine or engine for raising, removing, and carrying off earth, stones, or rubbish, so as greatly to facilitate, and render less laborious and expensive, the carrying on and executing the works of canals, &c. Dated March 10, 1798.

Benjamin Douglas Perkins, of King-street, Covent Garden, in the county of Middlesex, M. A.; for a certain discovery made by his father,

father, Elisha Perkins, of Plainfield, in Connecticut, in North America, Doctor of Physic; for a certain art of relieving and curing a variety of aches, pains, and diseases in the human body, by drawing over the parts affected, or those contiguous thereto, in certain directions, various pointed metals, and compounds of metals. Dated March 10, 1798.

William Bolton, Esquire, Captain in the Navy; for an improved capstan, to be used on board ships, in capstan-houses, wharfs, &c. or wherever any great weight is to be raised, or resistance overcome. Dated March 10, 1798.

William Lester, of Yardley Hastings, in the county of Nottingham, Farmer; for a harrow upon a new construction. Dated March 10, 1798.

Joseph Haycraft, of Greenland Dock, Rotherhithe, Block, Pump, and Gun-carriage maker; for a gun-carriage upon a new construction. Dated March 23, 1798.

James Douglas, of the parish of Christ Church, in the county of Surrey, Machinist; for machinery for shearing and cropping woollen cloth, with shears, knives, or cutters, put in operation by various powers. Dated March 30, 1798.

REPERTORY

OF

ARTS AND MANUFACTURES.

NUMBER L.

X. *Specification of the Patent granted to Mr.* JOHN CROOKS, *of Edinburgh, Chemist; for a new Method of making Soap, and Bleaching, by Means and Use of Mineral and Vegetable Alkalies.*

WITH A PLATE.

Dated Dec. 12, 1797.

TO all to whom these presents shall come, &c. Now KNOW YE, that in compliance with the said proviso, I the said John Crooks do hereby declare, that my said invention is described in manner following; that is to say, in making the soft soap, I use fish of any kind, whether in their original unmanufactured state, or in a state of refuse, after they have been used in other manufactures, such as, for example, after the oil has been boiled or taken from them. When they are in

in their original ſtate, I cut them acroſs, in two or more places, according to their ſize, and I ſteep them in cold water, and ſtir them about, till the blood is ſeparated from them, ſo that, when the water is let off, it may carry off the bloody particles with it. The fiſh are then cut, bruiſed, or maſhed, by means of any inſtrument by which other materials are cut, bruiſed, or maſhed: the intention of this is, to accelerate the diſſolution of the parts or ſubſtance of the fiſh, as hereafter mentioned; but, if they are not bruiſed, the diſſolution will take place, though it will be more ſlow. I then throw the fiſh, by means of iron or wooden ladles or ſhovels, into boiling vegetable leys, very cauſtic, of the common ſtrength of ſoap-boilers original (not waſte) leys; and which leys ſhould have been as lately made as poſſible, or at leaſt ſhould be taken from a veſſel in which they have been carefully cloſed up, and which ſhould not be above four or five days old. The proportion of leys to fiſh, is as ſix to ten parts, in weight. The fiſh ſhould be thrown into the leys gradually, according as what was before put in appears to be in a ſtate of diſſolution, or tending to it: they will diſſolve ſlow or faſt, in proportion to the ſtrength of the leys. The fiſh and leys are then boiled together, on a ſlow ſimmering fire, till the fiſh is compleatly diſſolved, which will be in from three to ſix hours, in proportion

to the quantity of fiſh. The point of diſſolution is known, when the liquor, being ſaturated, refuſes to diſſolve more; and, when it has arrived at that point, no more fiſh ſhould be added. After the fiſh has been diſſolved, it ought to be paſſed through a ſtrainer. Tallow or oil, ſuch as whale or ſoot or any coarſe oil, or indeed any oil, or tallow, in the proportion of one part of weight in tallow or oil, and eight parts of fiſh, is then to be thrown into the boiling veſſel, in which the heat ſhould then be increaſed; and the whole continue to be boiled, at a boiling heat, till they are thoroughly united; but, about an hour before they are thoroughly incorporated, I throw into the veſſel common turpentine; by which I do not mean oil of turpentine, but that ſubſtance known by the name of common turpentine, which is thicker than common treacle, (the intention of which is to prevent the fiſhy ſmell,) in the proportion of one part, in weight, of turpentine, to ſixteen parts of the other materials. I add then palm oil, in the proportion of one part, in weight, of oil, to thirty-ſix parts of the other materials: this is to improve the colour, when needful, otherwiſe it is unneceſſary. The ſoap muſt then be ſpread about three inches thick, in a cool place, and kept there for a month, before uſed; during which time, it muſt be turned every two or three days, with ſhovels or hoes.

To make hard Soap. Fiſh, when compleatly diſſolved with cauſtic vegetable leys, in the manner above mentioned, are to have tallow thrown into them, in equal parts with the fiſh, and both to be boiled at a boiling-heat, until they are thoroughly united. The veſſel is then to ſtand until cooled, in order to avoid the danger of its being cracked. And then, mineral leys, or mineral and vegetable leys together, both cauſtic, added to roſin, are to be thrown into the veſſel: the leys in the proportion of ſix parts, in weight, to twenty parts of fiſh and tallow joined together; and the roſin in the proportion of five parts, in weight, to twenty parts of fiſh and tallow joined together. The whole is to be boiled; and, in about an hour after, the ſtrongeſt waſte ſalt leys, from the ſoap works, (not original leys,) are to be added, in the proportion of two parts, in weight, to twenty-five parts. The whole muſt then be boiled the ordinary time, as already mentioned, till the power of the leys is ſpent; and then theſe powerleſs (commonly called waſte) ſalt leys are to be pumped up, and freſh cauſtic mineral (not vegetable) leys are to be added, in the proportion of ſix parts, in weight, to twenty-five parts, and the whole boiled till it become hard ſoap; which ſhould then be melted in water, in the uſual mode, and then put into frames, and cut into wedges, in the common way. If a better

better colour is wanted, palm oil, in the proportion above mentioned, may be added at the laſt boiling. In the different operations of diſſolving and boiling, above mentioned, the liquor ſhould be ſtirred about every ten or fifteen minutes, with an iron rake, or other inſtrument.

And, as fiſh are often driven on ſhore, in ſuch vaſt quantities that they are either not uſed at all, or uſed only for manure; to prevent this public waſte, I put them into receivers, and, by pouring over them ſtrong leys, ſufficient to cover them, within two or three days after the fiſh are taken, or within ſuch time as fiſh will commonly bear to be ſalted, I preſerve them for being afterwards, at leiſure, manufactured into ſaponaceous matter, or ſoap.

As to Bleaching, I take either ſoap-boilers waſte leys, or bleachers waſte leys, the laſt of which are got either from the boiling veſſel, called the bucking veſſel, or from the whitening veſſel, called the gas-liquor veſſel; and I put them into a caſk, or other veſſel of wood, or plate iron, which has two bottoms, ſeparate from each other about an inch and a half. The upper one is perforated with a number of ſmall holes: the under one has only one hole, of about an inch or more in diameter, according to the ſize of the veſſel. The interval between the two is filled with ſtraw, mats, ſmall pebbles, or other ſubſtances pervi-

ous

ous to water. The cask or vessel is then filled with the leys, the pure parts of which filtrate through the holes of the upper bottom, the substances between the two bottoms, and the hole in the under bottom; from which last they are received into a separate vessel, whilst the impurities remain behind.

From this receiver they are conducted, or pumped up, into a shallow pan or boiler, or more than one, of plate-iron, of whatever length and breadth is needed. The most commodious method, for expediting much work, seems to be two boilers, placed by the side of each other, divided by a common wall, each ten feet long, seven feet broad, by fifteen inches deep; of which, six inches to be of plate-iron, and nine inches to be of a crib of wood; but slanting outwards, to contain the more leys, and prevent them from boiling over. Here the leys are boiled, and evaporated down to the thickness of treacle.

Adjoining to this boiling vessel, or these two boiling vessels, and connected with it or them by a pipe or funnel, or by two pipes or funnels, (if two evaporating vessels are needed,) each one foot long, and nine inches diameter, there is an oblong vaulted kiln or oven, about ten feet long, six feet wide, and two feet and an half high, all built of brick; in which the leys, that have already been evaporated to the thickness of treacle, are

are calcined. If there be only one evaporating veſſel, the pipe or funnel, from the evaporating veſſel into the calcining-furnace, will be in the middle of both. But if there be two evaporating veſſels, ſeparated by a mid-wall, then the two funnels will be placed near the common wall, and pointing obliquely into the calcining-furnace, ſo that they may meet in one ſtream in a point, in order to increaſe, as in a focus, the power of the heat. I prefer two evaporating veſſels to one, becauſe much longer time would be required, to evaporate a certain quantity of liquid leys into a ſubſtance as thick as treacle, than to calcine that ſubſtance into a black ſalt, as hereafter mentioned; whereas, if the calcining-kiln be ſupplied only by one evaporating veſſel, it will frequently ſtop, and conſequently cool, for want of work. However, manufacturers may vary their forms and dimenſions at pleaſure, becauſe it will be eaſy to find out, by experience, the quantity of leys which can be evaporated, with moſt advantage to the manufacturer, in one veſſel of a certain ſize, and calcined in another veſſel of a certain ſize, and conſequently to proceed upon the proper proportions in forming the works. The ſame fire or fires, thus paſſing from the evaporating veſſel or veſſels into the calcining-kiln, will act as an air or reverberatory furnace, with the flame playing over the evaporated leys. Into this calcining-

furnace,

furnace, there is to be thrown charcoal, but first broke into the ſize of ſmall muſquet-ſhot, whether made of coal, wood, peat, or other combuſtible matter; or peat, or ſmallcoal, uncharred: charred ſaw-duſt is beſt. The proportion is one-ſixth, as near as may be, (for a ſmall variation will not be material,) of the weight of the évaporated leys; by this means, the combuſtible material will unite itſelf to the acid contained in the alkali of thè waſte leys of the bleacher, and to the acid contained in the common ſalt, in the waſte leys of the ſoap-boiler, in the calcining-furnace, and thus form a ſulphur with it, which will be diſſipated in the operation of calcination, and part of it will become *hepar ſulphuris*. There is alſo to be thrown into the calcining-furnace, new-burnt marble, as hot as can be drawn from the kiln, in the proportion of about one pound and a half of new-burnt marble, to eight pounds of evaporated leys; which new-burnt marble muſt be broke down or pounded to the ſize of a common hazle nut, and the marble muſt be compleatly free of any irony, clayey, or ſandy particles, or any other impurities. If marble is not to be got, lime may be uſed, but is not half ſo good. The difference between marble and lime is, that the firſt has no irony, clayey, ſandy, or other impure particles in it, whereas lime has. The reaſon for uſing the calcined marble when quite hot

from

from the kiln, is, that no time will be given for fixed air to get into it, and thereby weaken its power. But it is carefully to be attended to, that the evaporated leys, charcoal, or other above mentioned fuel, and calcined marble, muſt be thrown into the calcining-furnace altogether, at one time, and frequently ſtirred in the furnace, to make them unite, ſuch as once every ten or fifteen minutes. There the whole is to be calcined into a black ſalt: it will take from eight to eighteen hours, to calcine it properly.

When this black ſalt is formed and cooled, it is to be thrown into a hogſhead, or other wooden or iron plate veſſel, having a double bottom, perforated with ſmall holes in the upper, and with a large one in the under bottom, and the interval between the two ſtuffed with ſtraw, or mats, or pebbles, as above deſcribed; and, upon the upper bottom the black ſalts are to be laid, to the amount or quantity of two-thirds of the depth of the veſſel, and the remaining third to be filled with water, which is to be allowed to ſtand upon them twelve hours: during the four firſt of theſe twelve hours, the black ſalts are to be ſtirred about every ten or fifteen minutes; and, during all the time, the hole in the under bottom of the veſſel is to be kept ſhut, that the water may not eſcape.

Laftly, this hole is opened, and then the pure folution of the black falt will pafs through it into a feparate veffel, while the impurities remain behind, in the interval between the two bottoms. The folution is to be evaporated in one of the evaporating veffels, where it will be converted into grey falts, fit for bleaching, dying, or rectifying.

In this ftate, the grey falts may, in bleaching, be ufed with greater advantage than any other alkaline falt, for two reafons; the firft is, that its power will be increafed, in proportion to the power of the calcined marble in folution that is in it. Secondly, as the acid of thefe leys is decompofed into a *hepar fulphuris*, and, by the calcination, moftly thrown off, they become more powerful folvents, and are more fit to take off the original vegetable oil of the cloth, or yarn, in bucking, than common vegetable alkalies (which contain no *hepar fulphuris)* can be.

Having thus obtained an improved material for boiling the cloth, or yarn, in order to take the vegetable oils from them in the bucking veffel, I next proceed to apply and make it effectual in whitening them in the bleaching veffel, by another improvement. For this purpofe, I throw one pound of calcined marble, quite hot from the kiln, into any kind of veffel containing ten pounds of foft water; where, after being once ftirred about, it muft remain

clofe

close covered up for feven hours, or until the water has imbibed as much of the marble as it can, and then both are to be ftrained through a veffel with two fuch bottoms as above defcribed. After which, I impregnate this folution with the common materials of what is commonly called gas or chemical liquor, till the folution be fully faturated; the effect of which is, that the marble folution will imbibe far more gas than common water can; for, as it is certain that the more alkali there is in water the more gas will be imbibed in it, fo the folution of calcined marble, operating as alkali, and being a fubftitute for it, will imbibe far more gas than fimple water by itfelf can; and the effect again of this complication, by the addition of the power contained in the calcined marble, and of the power obtained by the increafed quantity of gas, will be, that this bleaching liquor will go farther in work, by admitting a greater quantity of water to be mixed with it in bleaching, and will moreover make that work better.

This is not all; I plunge the cloth, or yarn, from the bucking veffel, directly, and immediately, into the veffel in which the bleaching liquor, made as before mentioned, is contained, but without adding any new alkali to it; the effects of which are, firft, that the yarn, or cloth, when taken from the bucking veffel, having im-

bibed and been drenched with my improved material, which has all the effect, and more than the effect, of simple alkali, will save the expence of new alkali being put into the whitening vessel. Secondly, the improved material, thus imbibed in the cloth, or yarn, will, in the same manner as if it was common alkali, (for which it is a substitute,) destroy any acid, and consequently prevent the cloth, or yarn, being hurt by any acid, which, in making the gas-liquor, may have got over from the retort which contained the gas materials, into the receiver which contained the solution of marble. But, thirdly, it will make perfectly unnecessary the circuitous mode of bleaching used in most parts of Europe, and in too many of Britain and Ireland, of taking the cloth, or yarn, from the bucking vessel, and spreading it in the fields, to get the advantage of sun and air, (but by which they often expose them to the dangers of both,) and of boiling and re-boiling them, with a new charge of new alkali each time.

And, as some persons may not like the trouble or risk of combining either grey salts or other alkaline salts with calcined marble, I calcine either the one or the other with hot new-burnt marble, and put them, in a dry state, into stone vessels closely corked, and sealed with rosin, to prevent fixed air from entering, and thereby weakening their

their caufticity; fo that thefe perfons will have no trouble, but afterwards to diffolve them in water, as above mentioned, and to add the gas to the folution in the common way.

And as, in great towns or populous manufacturing neighbourhoods, the carriage of a bleaching material, even in a liquid ftate, (which I call bleaching liquor,) compofed of folution of marble and of gas, is of little confequence, in comparifon of the rifk, danger, and lofs of making fuch liquor improperly, and of fpoiling goods with it, (which fometimes happens to a very great amount,) I make the bleaching material in a liquid ftate; which, compofed of thofe two articles, well corked up, may be tranfported from place to place, and from time to time, during the fpace of five or fix days, with fafety; becaufe the folution of marble in it, acting like alkali, and being a fubftitute for alkali, will prevent the gas from being diffipated by the agitation of the water; which would happen, if there was nothing elfe but water and gas united together.

To facilitate, and render the difcovery of my inventions more compleat, a drawing of the neceffary works is fubjoined. (Plate V.) In witnefs whereof, &c.

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References to the Figures.

(See Plate V.)

Which are drawn on a ſcale of half an inch to a foot. The flue-pipe three-eighths diameter.

a. Damper to ſhut the flue, when the furnace is at work.

b. Damper to ſhut the flue, when the man is at work at the kiln.

c. Evaporating-pan.

d. Flue from the furnace to the kiln.

e. Extra-flue while charging and uncharging the kiln.

f. Kiln.

g. Door of ditto.

h. Flue from the kiln to the condenſer.

i. Condenſer.

j. Flue of ditto.

k. Opening to introduce the pump.

l. Fire-place of the furnace.

m. Aſh-pit of ditto.

Sir

Sir JOHN DALRYMPLE, *Bart. (who is concerned in the patent) having favoured us with the following account of his examination before a Committee of the House of Commons, we insert it, as a farther elucidation of the discovery contained in the foregoing specification.*

Queftions to Sir John Dalrymple, Bart. by a Committee of the Houfe of Commons, on the Fifheries.

Mr. Ryder in the Chair.

Queftion. What are the difcoveries or improvements which you have made in making foap from fifh?

Anfwer. Chiefly two, made by John Crooks, or me. Firft, we make foap by means of fifh, alkali, and tallow. Secondly, we make faponaceous matter from fifh and alkali; which may be preferved for months, or a year, and then turned into foap, by adding tallow to it. I confider the laft to be the moft important of the two, becaufe making foap from fifh is confined to the feafon of fifhing; that is, while the fifh continue frefh, and to the number of hands to be found to make foap immediately from them: whereas the faponaceous matter

matter is inſtantly made, and by few hands, and will keep long, to be converted into ſoap at leiſure, and can be carried from place to place, according as it ſhall be needed, to mix with tallow for ſoap-works.

Q. What kinds of fiſh do you uſe, and in what ſtate?

A. We began with the offal of whales; that is, with the refuſe of the fleſh of the whale, after the oil has been boiled from it; for which refuſe I paid 6 *s.* *per* ton; and I purſued it through every fiſh I found in market, and found them all ſucceed more or leſs, but with no great variation, except ſo far as related to the difference between hard or ſoft ſoap made from the ſame fiſh. With regard to the ſtate of the fiſh, I uſed the whale-offal when all the oil was taken from it; and white fiſh, either freſh, or verging to putridity.

Q. Did you uſe only their oily parts, or what parts of the fiſh did you uſe?

A. Oil has been made from fiſh, and ſoft ſoap has been made from the oil of fiſh, for ages paſt: but the ſingularity of our idea was, to throw heads, tails, bones, guts, ſkin, and, in ſhort, the whole of the fiſh, together; and I never found any difference between the oil taken off by itſelf, and this maſs taken altogether, to make ſoap; by which we did, at one operation, what other people did at two.

Q. What

Q. What are your operations and materials, and particularly, what is the proportion of tallow to the fish, to make hard soap, and what the proportion, to make soft soap?

A. My operations are the very same as in making common soaps; and the materials (except so far as relates to fish) are the same. The proportions to make hard soap, are one ton of fish to one ton of tallow; but, to make soft soap, are eight tons of fish to one ton of tallow. From which consumption of the expensive article of tallow in the one case, and the saving of it in the other, I conclude, that the national saving must lie in the use of soft soap, which is fitted for nine parts out of ten of mankind, as I shall afterwards explain.

Q. What will be the saving in the expence, on the hard soap and soft soap?

A. It will be proportioned to the saving of tallow in the two cases, but I cannot say how much.

Q. Can you give to the soft soap such a degree of consistence as will make it divisible into parts, like hard soap?

A. My original idea was, to make soft soap at a cheap rate, for the soldiers and seamen, who, of one sort or other, are 400,000 in number, and I said so to the Duke of York and Lord Spencer. I carried it to Captain Shank, of the navy, who said it could not be used by them, because, being of a soft texture, it could not be divided

among the men, as hard ſoap was, which was cut into wedges, and therefore I dropt that thought; but having, at the end of three months, examined it by accident, I was ſurpriſed to find, that, by the mere lapſe of time, the aqueous parts had been carried off, and that it was of a diviſible conſiſtence. One of my ſervants told me he had ſome ſtill harder; and, when I aſked him how that had happened, he ſaid he had made ſome for his own private uſe, into which he had put ſome roſin. From theſe two circumſtances, I am apt to think, that ſoft ſoap from fiſh may be made of a firm and diviſible conſiſtence.

Q. Will the fiſh-ſoap pay the bottoms of ſhips, and ſerve in launching them?

A. I ſhewed this ſoft ſoap to Captain Shank, who ſaid that it would.

Q. Will the ſoft ſoap ſerve in the manufacture of woollen?

A. I am told by ſoap-makers and manufacturers that it will. One of the laſt is now uſing it near London, from the ſecond or third parcel that I ever made, with my ſervants, who had never made a pound before.

Q. Will the ſoap ſerve for waſhing?

A. A number of ſervant maids, ſerjeants' and ſeamen's wives, tried the ſoap, and never complained, except once or twice, when too much alkali put into it ſmarted their hands.

Q. Does

Q. Does it ſerve for ſhaving?

A. I have ſhaved with the hard or ſoft ſoap indiſcriminately: many of my friends have ſhaved with the hard ſoap. The Duke of Portland and Lord Spencer made no complaint.

Q. What are the trials you have made?

A. Mr. Bonney, an eminent ſoap-maker at Liverpool, made it firſt with offal of whales, next with white fiſh, and laſtly with whale-blubber. I made it in Scotland and London with every ſea fiſh that I could find. The Board of Trade here ſent directions to the Board of Fiſheries in Scotland, to make trial on a large ſcale, and report. They made half a ton of hard ſoap from herrings, and are now making another half ton from dog-fiſh, and are ſoon to make ſoft ſoap, and to report.

Q. Have you letters, or information, to make you believe that in the Britiſh ſeas there are fiſh enough, and at Newfoundland refuſe of fiſh enough, to ſupply ſaponaceous matter, to be afterwards turned into ſoap in Britain, by joining with it portions of tallow, ſo as to ſerve the markets of Britain, and perhaps of Europe?

A. I have various letters to that purpoſe. I produce a copy of one of them, from a ſoap-boiler * who

* The letter here referred to (which is from Mr. Jameſon, ſoap-boiler, of Leith) ſays, "the immenſe fiſhing now in the "Firth, ſhould it continue every ſeaſon, will furniſh an "ample ſource of materials for all the ſoap-makers in Bri-"tain."

who pays, or paid, (I forget which,) one ſixth of the ſoap tax of Scotland. Mr. Jeffery, member for Pool, told me he could ſend, from Newfoundland, as much ſaponaceous matter, from the refuſe of cured fiſh, and fiſh driven on ſhore, as would ſerve all England, provided he could get alkali in Newfoundland.

Q. What do you imagine is the amount of the ſoap made in Britain?

A. 1,500,000 *l.* a year; which I calculate by comparing the produce of the tax with the value of the ſoap made. The tax upon hard ſoap is 2¼*d.* *per* pound: the value is about 7*d.* *per* pound. The tax yields 500,000 *l.* a year; therefore the value of the ſoap muſt be 1,510,000 *l.* I do not indeed take into my calculation the ſmaller tax of ſoft ſoap, becauſe I have not taken in the part of both of which the revenue is defrauded, but left the one to balance the other. Of this, there goes a million ſterling yearly, for tallow, to Ruſſia or Spain, which I calculate by the proportion between the value of tallow and ſoap, *viz.* $\frac{2}{3}$.

Q. Is there any thing ſingular in the preſent ſtate of Europe, which would call for an unuſual demand from England, if ſoap could be got cheap?

A. Yes, the nations at war with England are in want of ſoap, becauſe they cannot ſend their ſhips to the Baltic for tallow. The French are ſo hard run, that they make a miſerable ſoft ſoap (which I have

I have alſo made) from old rags, the refuſe of wool *, and other impurities, contrived by Monſieur Chaptal.

Q. What are the political advantages of eſtabliſhing a manufacture of ſoap from fiſh?

A. I reaſon in the following circle. The empire cannot ſubſiſt without a navy; the navy without ſeamen; the ſeamen without a nurſery of fiſheries; and the fiſhers without markets. The French have ſtruck us from our markets in Holland, Flanders, France, Spain, and the Mediterranean. But we ſhould not feel the blow, if we had ſoap to ſupply even thoſe nations; and it is impoſſible for them to do without it, as long as there are woollens, linens, cottons, and ſilk, to be waſhed in Europe.

Q. What are the advantages of making ſoap from fiſh, over ſalting it?

A. Firſt, it requires no ſalt. Secondly, it employs more hands, coals, and other materials. Thirdly, it conſumes the refuſe of the fiſh which have been ſalted. Fourthly, it will conſume the offal of whales, which at preſent are thrown to the dunghill, and alſo thoſe myriads of fiſh which are driven on ſhore on the coaſts of the Britiſh iſles, by tempeſts, or the purſuit of voracious fiſh. Mr. Fordyce, of the Houſe of Commons,

* See Vol. VII. p. 346. of this work, which Sir John Dalrymple informs us firſt furniſhed him with the idea of theſe diſcoveries.

told

told me that he once bought ſome tons of herrings, which had been driven on ſhore on his eſtate, for a bottle of brandy. Laſtly, the ſalting buſineſs can take place only in the fiſhing ſeaſon, when the fiſh are freſh; whereas the other will have three working times. Firſt, the freſh fiſh will be ſalted. Secondly, thoſe turned to putridity, even though three or four weeks old, may be turned into oil. Thirdly, the refuſe of both, and the ſuperabundance of fiſh which cannot be uſed in ſalting, or making oil, can be turned into ſaponaceous matter, and made into ſoap during all the reſt of the year.

Q. What are the proper places for ſuch an eſtabliſhment?

A. Cornwall, for pilchards; the Iſles of Man or Angleſey, for cod; Shetland and the Firth of Forth, for herrings, where they are to be had for 2 *l.* a ton; but, above all, Hartlepool, if the fiſh be as numerous as I have heard, becauſe, to that rendezvous on the eaſt ſide of the iſland, might be brought the offal of the whales of Scotland, Newcaſtle, Whitby, Hull, and London.

Q. What do you know of the dog-fiſh for the purpoſe of making ſoap?

A. I know nothing of dog-fiſh myſelf, but have been told by ſoap-makers, that they would make ſoap beſt. The duke of Athol told me, that they were in vaſt numbers round his Iſle of Man, de-

ſtroyed

ſtroyed the herrings, cod, and other fiſh, and were called the tyrant of the ſea there. To which Sir Joſeph Banks added, that they were a real ſmall ſhark, which not only deſtroyed the fiſh, but prevented fiſhers from getting fiſh, becauſe they ſwallowed the bait and hooks, entangled the nets, and, when the fiſhers took them, they threw them away.

Q. Will the preſent duties require to be varied, ſo far as relates to ſoap made of fiſh?

A. They will not, if the ſoap can be made as cheap as I think, otherwiſe the tax muſt be accommodated to the value.

Q. Do you think that a bounty ſhould be granted on making ſoap from dog-fiſh?

A. Commercial and political intereſts both require it.

Q. Have you thought of any plan, whereby the converſion of fiſh into ſoap may be brought into public notice and uſe, without putting the public to expence, and with a ſaving to the public? What may that ſaving be, and on what do you calculate?

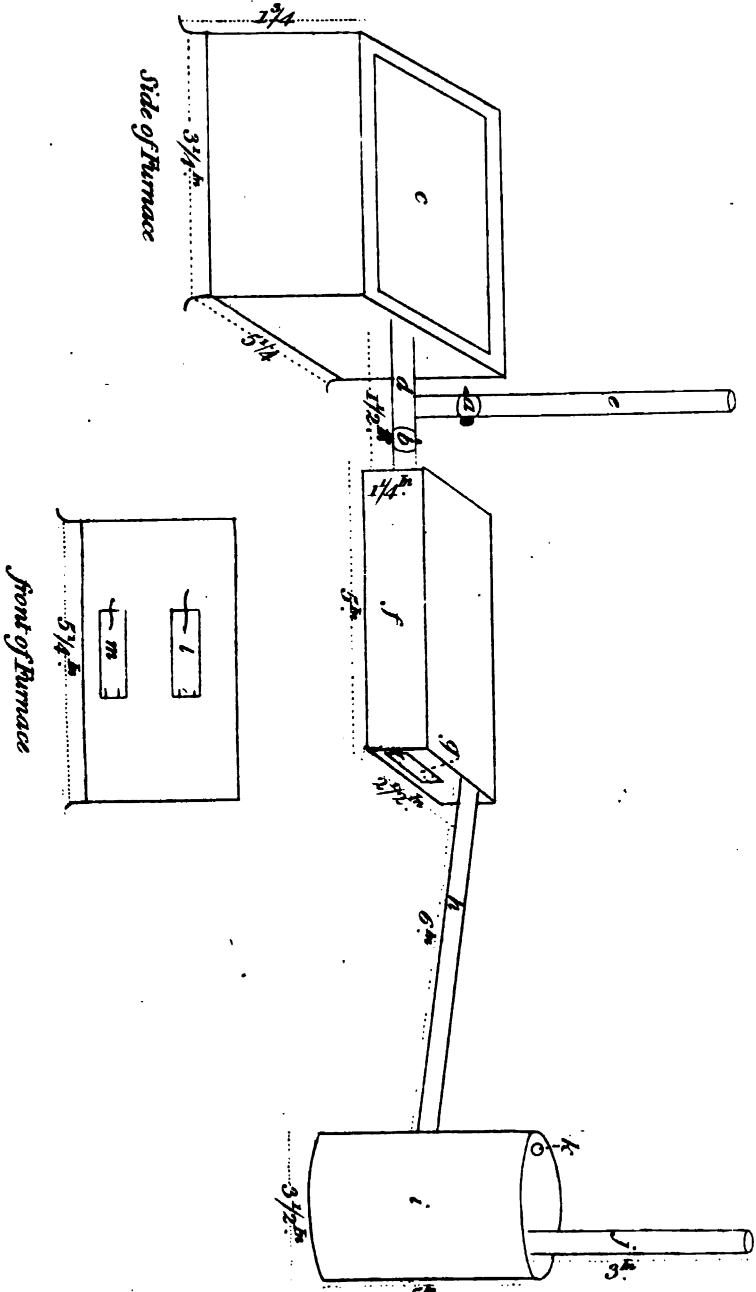
A. Government has works at different ſtations, carried on at its own expence, for bread, beer, portable ſoup, ſour-crout, &c. for the ſeamen. Now, my idea is, that they ſhould have one work in Cornwall, and another in the North, or at leaſt one ſomewhere, to make ſoap for the ſeamen and ſoldiers.

ſoldiers. A ſoldier is allowed 17*s.* and 4*d.* a year for waſhing; and, I believe, a ſeaman coſts ſtill more. A ſaving of 5*s.* a year on each man, at this rate, would be 100,000 *l.* a year. But this is a trifle, in compariſon of preſerving the health of the men, and therefore it would be better to give them more of the ſoap, and at a cheaper rate. It is known to the experience of every one, that clean woollen and linen contributes to the health, and conſequently to the ſpirits, of men.

Q. Have you a patent?

A. Having been careleſs in talking of our contrivances, I was afraid that ſome perſon might ſteal out a patent againſt us, uſe it as a monopoly, and turn it into a reſtraint againſt government itſelf. But my intention was, to ſurrender the patent to the public, if it interfered with the public intereſt, on getting ſome ſhare of the ſaving, if there was a ſaving, and nothing, if there was none; and to leave the adjuſtment to Lord Liverpool, to whom alone the public owes my ſucceſs, if I ſhall be ſucceſsful, becauſe he kept up my ſpirits when almoſt every body elſe was prejudiced againſt the attempt.

XI.


Side of Furnace
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XI. *Specification of the Patent granted to Mr.* WILLIAM MURDOCK, *of Redruth, in the County of Cornwall, Gentleman; for a Method of making (from the same Materials, and by Processes intirely new,) Copperas, Vitriol, and different Sorts of Dye or dying Stuff, Paints, and Colours; and also a Composition for preserving the Bottoms of all Kinds of Vessels, and all Wood required to be immersed in Water, from Worms, Weeds, Barnacles, and every other Foulness which usually does or may adhere thereto.*

Dated May 2, 1791.

TO all to whom these presents shall come, &c. NOW KNOW YE, that I the said William Murdock, in compliance with the said proviso, do hereby describe and ascertain the nature of my said invention, and declare that the same is to be performed in manner following; that is to say, to make the yellow paint and dying-stuff, and for preserving ships' bottoms, and other wood immersed in water, from worms or other foulness, take any quantity of pyrites, (commonly called,

in Cornwall, mundick;) which pyrites or mundick contains ſulphur, arſenick, and ores of zinc; or take any minerals or ores which contain ſulphur, arſenick, and ores of zinc: put the ſame into a kiln, houſe, oven, cone, or heap, covered nearly cloſe, and then ſet the ſame on fire, admitting no more air than is ſufficient to cauſe the ſaid pyrites, mundick, or other minerals or ores, to burn; the fume or ſmoke of which muſt be conducted through a flue or conductor, from the top, ſide, or bottom, of ſuch houſe, kiln, oven, cone, or heap, into a receiver, in which receiver the ſmoke is condenſed; by means of which condenſation, a fine yellow powder, fit for painting, dying, paying and preſerving ſhips' bottoms, and all wood immerſed in water, is produced in the receiver. Or, take any quantity of ores of arſenick and ſulphur, called pyrites, and commonly diſtinguiſhed, in Cornwall, by the name or appellation of mundick, and add thereto about one-ſixth part of the ores of zinc; which, being burned or condenſed in manner before mentioned, produces a fine yellow powder, fit for painting, dying, and paying and preſerving ſhips bottoms, and all wood immerſed in water, as aforeſaid; and, by increaſing or leſſening the quantity of ores of zinc added to the pyrites, various tints in the ſaid yellow powder will be produced, according

cording to the quantity of ores of zinc ſo added to the pyrites. Or, take the ores of arſenick and ſulphur, called pyrites or mundick, and burn and condenſe the ſame, as herein before mentioned; and this will alſo produce an inferior kind of yellow powder, but equally good with the before-mentioned powder, for paying or preſerving ſhips' bottoms, or other wood immerſed in water. And, to make green vitriol or copperas, take any quantity of the remains of the above calcined ores or minerals, after the ſame are burned, and waſh the ſame in water, and then place ſuch water on the top, or any other part of the aforeſaid kiln, houſe, oven, cone, or heap, whilſt burning; and cauſe the water to evaporate by the heat of the ores or minerals, then burning in the ſaid kiln, houſe, oven, cone, or heap. Or, cauſe the ſaid water to evaporate, by the heat of the ſun, to a cryſtallizing point, and let the ſame ſtand for twenty-four hours, or longer, and cryſtals of copperas or green vitriol will thereby be produced. In witneſs whereof, &c.

XII. *Specification of the Patent granted to Mr.* CHRISTOPHER WILSON, *late of Scarborough, in the County of York, Master Mariner, but now of Westminster; for a Method of combining Timbers, applicable to the Improvement of Naval Architecture, and all ponderous and large Works composed of Wood.*

WITH A PLATE.

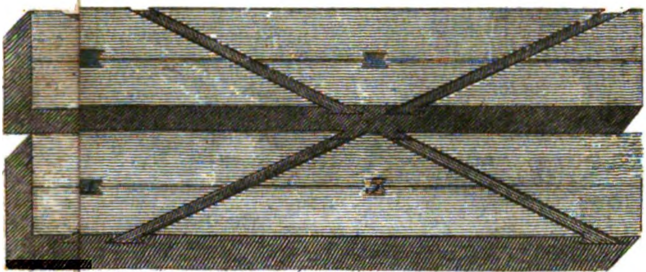
Dated Oct. 15, 1795.

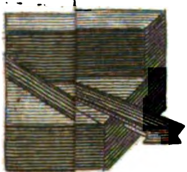
TO all to whom these presents shall come, &c. NOW KNOW YE, that in obedience to the said letters patent, and the proviso therein contained, I the said Christopher Wilson do hereby describe and ascertain the nature of my aforesaid invention, and the manner in which the same is to be performed, in manner following; that is to say, to make masts, beams, or other works composed of wood, by combining timbers according to my said invention, four or more pieces of timber are to be laid together, as represented by the figures marked A and B, contained in the plan or drawing

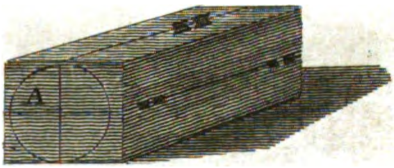
ing annexed hereto, (see Plate VI.) both which shew the end-view of the timbers; A, containing a combination of four, and B, of nine pieces of timber. To combine these, dove-tail or plain mortises are to be cut, of a diagonal or inclined direction, as represented in the four timbers described in the said plan or drawing, and marked C, D, E, and F; half of each mortise to lie in C and D, and half in E and F; and similar mortises are also to be cut through the right-angle junction of the four timbers, as represented therein by the numbers 1, 2, 3, 4, and 5; after which, the face C and D being laid on E and F, a dove-tail or plain slott, lock, or bolt, made of wood, is to be driven tight through each mortise, as exhibited by Figure G, in the said plan or drawing, which represents three of such timbers, with the slotts, locks, or bolts, driven therein; the fourth being omitted, to shew the direction of the slotts, locks, or bolts, when the four are united: at the extremity of each slott, lock, or bolt, wedges made of wood or metal may be driven, where deemed necessary. By this method, numerous timbers may, in like manner, be combined, according and in proportion to the thickness and strength required; the same slott, lock, or bolt, in every instance, being made to pass diagonally through the diameter of the whole. In

producing long pieces of timber by this method, the end junctions muft be fufficiently floped, and lie over each other; and each union of ends muft be fo difpofed of, throughout the whole length, that two end-joints may not be oppofite or near each other; and the work may, where neceffary, be rounded off, as defcribed by the circles on the aforefaid figures A and B, in the faid plan or drawing. The fame method of driving flotts, locks, or bolts, diagonally into mortifes, may be practifed with great advantages between the ribs, timbers, or frames of fhips, either in building or repairing, as exhibited by figure H in the faid plan or drawing; and likewife in every other part of fhipping, and other large and ponderous works compofed of wood, where ftrength and durability are required. In witnefs whereof, &c.

XIII.



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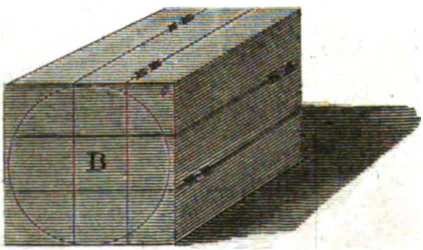
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XIII. *Specification of the Patent granted to Mr.* William Whitmore, *of Birmingham, in the County of Warwick, Engineer; for Improvements in Machines or Engines for weighing Waggons, and all other Carriages, as well as Goods or Wares, of any Kind whatever.*

Dated Jan. 26, 1796.

To all to whom these presents shall come, &c. Now know ye, that in compliance with the said proviso, I the said William Whitmore do hereby declare, that the following is a particular description of my said invention, and the manner in which the same is to be performed; that is to say, my method and principal improvements in making machines or engines for weighing waggons, and all other carriages, as well as goods or wares, of any kind whatever, (they being mostly placed in very damp places,) consists in securing the working parts from rust, and reducing the friction, and in making the fulcrums and bearings of such materials as are not liable to be injured by

by ruſt; for which purpoſe, they are ſo contrived, that the ſaid fulcrums, with their bearings, are ſurrounded or incloſed within a box or trough, that has oil (or any other liquid or ſubſtance capable of producing the ſame effect) put into the ſame, and therewith filled, till the edges of the fulcrums are completely immerged in the ſaid oil or liquid. The whole ſhould be then covered with leather, braſs, wood, or any other material, ſo as to prevent duſt or dirt getting into the boxes, whereby the edges are preſerved to a great length of time, and the machine is more accurate, and leſs liable to be out of order. The levers in which the fulcrums are placed, ſo as to ſuſtain the bridge, are made of various forms and materials, ſuch as wood, caſt-iron, wrought-iron, &c. &c. and the boxes are faſtened on as the engineer may think beſt, ſo as they are capable of containing oil, or any other liquid, and in many inſtances applicable to old engines already erected. In witneſs whereof, &c.

XIV. *Attempt to introduce a better Method of working Ships' Pumps than those in Common Use. By Mr.* Robert Clarke, *Surgeon, in Sunderland.*

WITH A PLATE.

THE object of this paper is, to supersede the mode of working common pumps by what is called a brake. To employ much reasoning, in proving the oppressive nature, and trifling effect, of an exertion which so many seamen and others have felt to their cost, and loudly complained of, may to some appear unnecessary; but, that we may not be charged, by others, with having taken too much for granted, it is proper to examine it particularly.

In the first place, the posture is weak, and much force is necessary to preserve it. It oppresses the man by over-stretching his loins, on one side, and incommodes respiration by the flexure of the other side. The motion of the shoulder-joint is too large. The muscles which act on the arm-bone at this joint are vastly dis-

proportionate to the charge they ſuſtain, when the arm vibrates on the ſhoulder-joint as a centre, and the force is communicated by the hand. Beſides this, the arms themſelves are at one inſtant enfeebled by being thrown above the head, at another battered to numbneſs by violent ſhocks downwards.

The changes of direction in the effort and ſuſtaining-force are continual and rapid, and the body is a continued dead weight upon the legs.

The action of rowing has not a defect I can diſcover. It is powerful to a ſurpriſing degree, and ſo well adapted to a man's eaſe, that he can continue it a great length of time without fatigue. The motion is large, but is made up of eaſy motions in ſeveral joints. The velocity and reſiſtance ſuit the muſcles employed: very little ſuſtaining force is needed, for the body is ſupported, and returns unloaded to its charge. To conclude: the poſture is ſtrong; the breathing free; and, happily for our purpoſe, it is the daily exerciſe of ſeamen, and may be applied to the working of ſhips' pumps with the mere intervention of a crooked lever.

Different circumſtances having conſpired to draw my attention to mechanical reſearch at an early age, and my profeſſional ſtudies having added the aſſiſtance of anatomy, I have occaſionally amuſed myſelf with inveſtigating different

modes

modes of applying manual force. I have felt myself diſſatisfied with many; but with none ſo much as with the common way of pumping ſhips.

I viewed the ſeaman cut off from the aſſiſtance of his fellow-creatures; and his life, and often immenſe property, dependant on the efficacy of a pump. The beſt-conſtructed veſſels are ſubject to numerous accidents which may render them leaky; and yet the only means of clearing them (large veſſels excepted) is a pump, to be wrought by manual labour, applied in a manner the moſt oppreſſive and ineffectual within the field of mechanics.

To introduce a better method, I have been at much pains and ſome expence; but a ſucceſs highly grateful to me has followed my exertions. So long ago as the year 1792, I revolved the matter in my mind, and came to the deciſion, already ſtated, in favour of the action of rowing, as a mode of working ſhips' pumps. I made models and drawings, repreſenting different ways of putting the contrivance in practice; but, from a variety of purſuits occupying the whole of my leiſure, it was not until January, 1797, that an opportunity occurred of giving a trial to the plan.

A trial was then made on board the Archimedes, Captain James Hills, a fine new veſſel, of 350

tons burthen, and belonging to this port. Two common pumps, with caſt-iron chambers, five inches and a half diameter, were placed in the uſual manner: one was mounted with an ordinary brake; the other with the crooked lever, as repreſented in Fig. 1. (See Plate VII.) The pumps were repeatedly wrought, in the preſence of ſeveral parties, conſiſting of people of conſequence, and of judgement in theſe matters, with an uniform deciſion in favour of the crooked lever; the pump to which it was affixed delivering more than twice as much water as the other, in a given time, and with leſs labour: each pump was worked by two men. The pumps were equally well made; and that one wrought by the brake delivered as much as any pump mounted in that way could do. The apparatus was by no means cumberſome upon deck. The veſſel was ſnow-rigged; and the ſeat, which was movable, hooked to the tri-ſail-maſt, and alſo to the combings of the pump. The whole of the working parts, and the ſeat, were kept below deck, when not employed.

Innovations in any line are cautiouſly admitted: in moſt caſes this is proper; with nautical men perhaps peculiarly ſo. A doubt prevailed leſt the toſſing of the ſhip, when at ſea, and expoſed to the breakers paſſing over her, might not deſtroy the

the advantage of the new method: this doubt, however, was ſoon removed.

The firſt voyage the veſſel made was to the Baltic; ſhe had a very ſtormy paſſage, and made much water. Here the character of the invention became ſettled; for, after repeated trials, the crew gave it ſo decided a preference, that, when one pump only was to be wrought, they uſed this; and, when both pumps were needed, they ſtrove who ſhould get to the new one. The impreſſion made by ſufferings on the minds of ſeamen are proverbially tranſient: this remark, however, has its exceptions; for the report of the above-mentioned ſhip's crew did as much credit to their hearts, as it gave unalloyed pleaſure to my feelings.

Explanation of the Figures.

(See Plate VII.)

Fig. 1. repreſents a ſtarboard ſide-view of the apparatus. A, the main-maſt. B C D, the crooked lever. E, the rod of the handle, at which two men, ſeated, draw as if rowing. F, the ſpear of the pump. G, the pump, which, for this

this proportion of lever, and quantity of moving power, is five inches and a half diameter in the working-chamber, and eighteen feet lift.

Fig. 2. reprefents the fame apparatus, feen from before. A, the main-maft. Both pumps are feen in this view, where references are omitted, as unneceffary.

Fig. 3. exhibits the handle, as it appears when viewed from above. A, a ftud, which, being inferted into one of the holes of the crooked lever, at D, receives a fore-lock. B, a joint in the handle, by means of which the wooden crofs-head C, may be folded clofe to the crooked lever, when not in ufe.

XV.

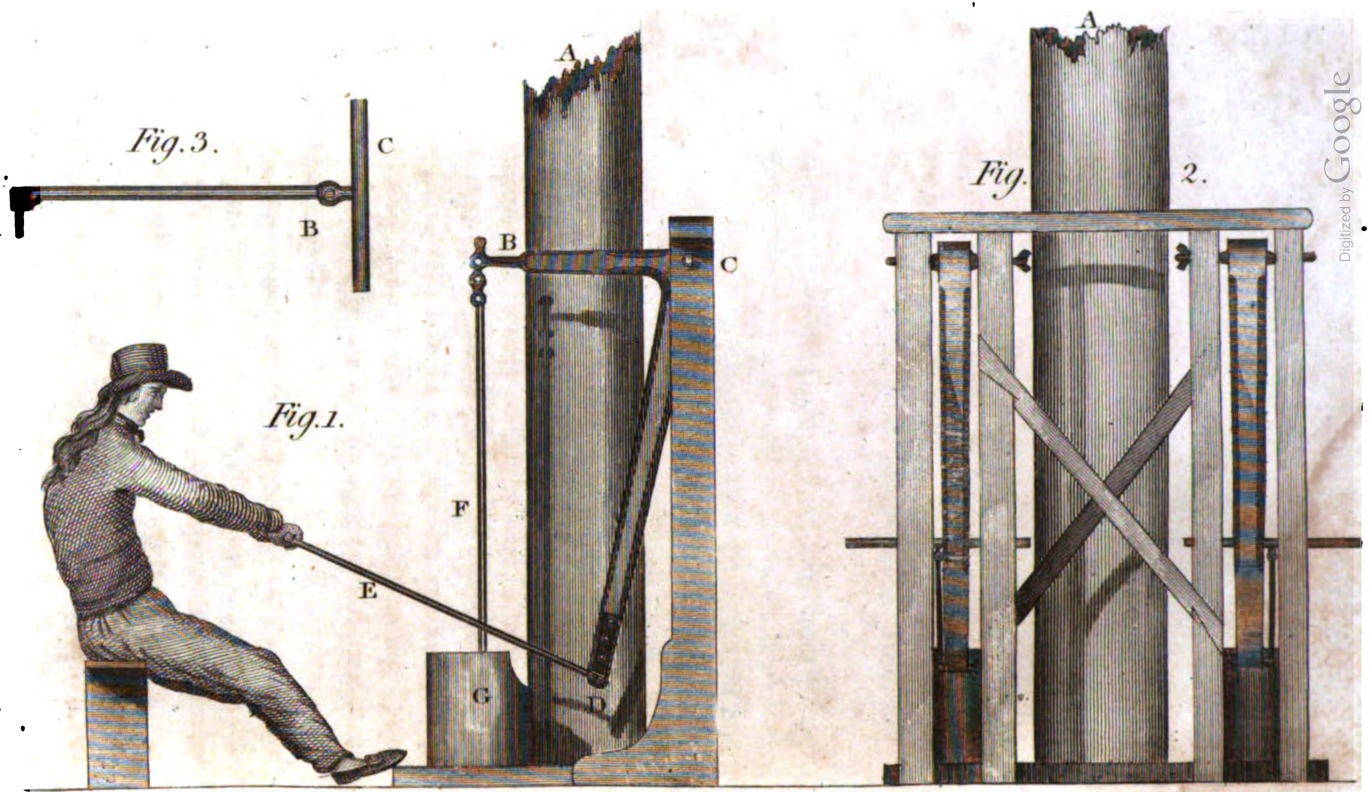
Fig.3.
A
B
C
Fig.1.
A
B
C
D
E
F
G
Fig. 2.
A

XV. *On a new Method of preparing a Test-Liquor, to shew the Presence of Acids and Alkalies, in chemical Mixtures. By* James Watt, *Esquire, of Birmingham, Engineer.*

From the Philosophical Transactions of the Royal Society of London.

THE ſyrup of violets was formerly the teſt of the point of ſaturation of mixtures of acids and alkalies which was principally uſed; but, ſince the late improvements in chemiſtry, it has been found not to be ſufficiently accurate, and the infuſion of turnſol, or of an artificial preparation called litmus, has been ſubſtituted in the place of it.

The infuſion of litmus is blue, and becomes red with acids. It is ſenſible to the preſence of one grain of common oil of vitriol, though it be mixed with 100,000 grains of water; but, as this infuſion does not change its colour on being mixed with alkaline liquors, in order to diſcover whether a liquor be neutral or alkaline, it is neceſſary

ceſſary to add ſome vinegar to the litmus, ſo as juſt to turn the infuſion red, which will then be reſtored to its blue colour, by being mixed with any alkaline liquor. The blue infuſion of litmus is alſo a teſt of the preſence of fixed air in water, with which it turns red, as it does with other acids.

The great degree of ſenſibility of this teſt would leave very little reaſon to ſearch for any other, were there reaſon to believe that it is always a teſt of the exact point of ſaturation of acids and alkalies, which the following fact ſeems to call in queſtion.

I have obſerved, that a mixture of phlogiſticated nitrous acid with an alkali, will appear to be acid, by the teſt of litmus, when other teſts, ſuch as the infuſion of the petals of the ſcarlet roſe, of the blue iris, of violets, and of other flowers, will ſhew the ſame liquor to be alkaline, by turning green ſo very evidently as to leave no doubt.

At the time I made this diſcovery, the ſcarlet roſes, and ſeveral other flowers whoſe petals change their colour by acids and alkalies, were in flower. I ſtained paper with their juices, and found that it was not affected by the phlogiſticated nitrous acid, except in ſo far as it acted the part of a neutralizing acid; but I found alſo, that

paper ſtained in this manner, was by no means ſo eaſily affected by acids of any kind as litmus was, and that in a ſhort time it loſt much of that degree of ſenſibility it poſſeſſed. Having occaſion, in winter, to repeat ſome experiments in which the phlogiſticated nitrous acid was concerned, I found my ſtained paper almoſt uſeleſs. I was therefore obliged to ſearch for ſome ſubſtitute among the few vegetables which then exiſted in a growing ſtate; of theſe, I found the red cabbage *(braſſica rubra)* to furniſh the beſt teſt, and, in its freſh ſtate, to have more ſenſibility, both to acids and alkalies, than litmus, and to afford a more deciſive teſt, from its being naturally blue; turning green with alkalies, and red with acids: to which is joined the advantage of its not being affected by phlogiſticated nitrous acid, any farther than it acts as a real acid.

To extract the colouring matter, take thoſe leaves of the cabbage which are freſheſt, and have moſt colour; cut out the larger ſtems, and mince the thin parts of the leaves very ſmall; then digeſt them in water, about the heat of 120 degrees, for a few hours, and they will yield a blue liquor, which, if uſed immediately as a teſt, will be found to poſſeſs great ſenſibility. But, as this liquor is very ſubject to turn acid and putrid, and to loſe its ſenſibility, when it is wanted to

be preſerved for future uſe, the following proceſſes ſucceed the beſt.

1. After having minced the leaves, ſpread them on paper, and dry them in a gentle heat. When perfectly dry, put them up in glaſs bottles, well corked; and, when you want to uſe them, acidulate ſome water with vitriolic acid, and digeſt or infuſe the dry leaves in it until they give out their colour; then ſtrain the liquor through a cloth, and add to it a quantity of fine whiting, or chalk, ſtirring it frequently until it becomes of a true blue colour, neither inclining to green nor to purple: as ſoon as you perceive that it has acquired this colour, filter it immediately, otherwiſe it will become greeniſh, by longer ſtanding on the whiting, or chalk.

This liquor will depoſit a ſmall quantity of gypſum, and, by the addition of a little ſpirit of wine, will keep good for ſome days; after which, it will become a little putrid and reddiſh: if too much ſpirit is added, it deſtroys the colour. If the liquor is wanted to be kept longer, it may be neutralized by means of a fixed alkali, inſtead of whiting or chalk.

2. But, as none of theſe means will preſerve the liquor long without requiring to be neutralized afreſh, juſt before it is uſed; and, as the putrid and acid fermentation which it undergoes,

and

and perhaps the alkalies or ſpirit of wine mixed with it, ſeem to leſſen its ſenſibility; in order to preſerve its virtues, while it is kept in a liquid ſtate, ſome freſh leaves of the cabbage, minced as has been directed, may be infuſed in a mixture of vitriolic acid and water, of about the degree of acidity of vinegar; and it may be neutralized, as it is wanted, either by means of chalk, or of the fixed or volatile alkali. But it is neceſſary to obſerve, that if the liquor has an exceſs of alkali, it will loſe its colour, and become yellow, from which ſtate it cannot be reſtored; therefore care ſhould be taken to bring it very exactly to a blue, and not to let it verge towards a green *.

By the ſame proceſs, I have made a red infuſion of violets, which, on being neutralized, forms at preſent a very ſenſible teſt; but how long it will preſerve its properties I have not yet determined. Probably the coloured infuſions of

* Since writing the above, I have found that the infuſions of red cabbages, and of various flowers, in water acidulated by means of vitriolic acid, are apt to turn mouldy in the ſummer ſeaſon; and alſo, that the moulding is prevented by the addition of ſpirit of wine. The quantity of ſpirit which is neceſſary for this purpoſe, I have not been able to aſcertain; but I add it by little at a time, until the progreſs of the moulding is prevented.

other flowers may be preferved in the fame manner, by the antifceptic power of the vitriolic acid, fo as to lofe little of their original fenfibility. Paper frefh ftained with thefe tefts, in their neutral ftate, has fufficient fenfibility for many experiments; but the alum and glue which enter into the preparation of writing-paper, feem, in fome degree, to fix the colour; and paper which is not fized, becomes fomewhat tranfparent, when wetted, which renders fmall changes of colour imperceptible; fo that, where accuracy is required, the teft fhould be ufed in a liquid ftate *.

* I have found that the petals of the fcarlet rofe, and thofe of the pink-coloured lychnis, treated in this manner, afford very fenfible tefts.

XVI.

XVI. *On the Action of Metallic Oxides and Earths upon Oils, in low Degrees of Heat.* By Mr. Peter Henry.

From the Memoirs of the Literary and Philosophical Society of Manchester.

THE high degree of colour poſſeſſed by many of the expreſſed and fatty oils rendering them unfit for ſeveral uſes in the arts, it appeared to be a deſirable object to diſcover a mode of depriving them of their colouring particles.

For this purpoſe, the following experiments were inſtituted.

1. Two ounces of ſpermaceti-oil were digeſted with one drachm of white arſenick, in a heat of 180° of Fahrenheit, during ſix hours; and left to ſtand till morning. The oil was then perfectly clear and colourleſs, and much heavier than it was previous to the experiment: a great part of the arſenick, however, remained undiſſolved, at the bottom of the digeſting veſſel.

2. Two ounces of linſeed-oil were digeſted with one drachm of white arſenick, under the ſame circumſtances with the former. In the morning, very

very little alteration being perceived in the mixture, it was expofed to a fomewhat greater heat. In two hours, the oil appeared brighter and clearer, much of the arfenick being diffolved; but it yet retained a great part of its original colour. There was a confiderable depofition of mucilage; the arfenick which remained undiffolved being tinged of a light yellow colour.

3. Green olive-oil was treated in a fimilar manner with the fpermaceti-oil, and attended with the fame refult.

4. Thick train-oil was digefted with a drachm and a half of white arfenick. No great alteration was obferved in the colour of the oil, though it was evidently rendered clearer, and more limpid.

When the oils were at the greateft heat, a brifk effervefcence took place, in all of them, upon fhaking the bottles, but immediately difcontinued, on the arfenick being fuffered to fubfide. When poured on the hands, they inftantly fhrivelled the fkin, and were either abforbed, or foon dried up. Two phials of N°. 1 and 2, being left expofed to the action of air and light, for fome months, were not in the leaft changed.

As it was evident, that a confiderable portion of arfenick was diffolved in all the foregoing experiments, I wifhed to fee if it could be precipitated, and at the fame time the oils be left pure, and deprived of colour; though with no great hopes

hopes of ſucceſs, from the known property of the mineral acids to render oils thick and diſcoloured.

5. Part of N°. 1 being poured into a phial, three or four drops of ſtrong vitriolic acid were added. The arſenick immediately precipitated, leaving the oil as pure and colourleſs as before.

6. The ſame quantity of vitriolic acid being added to N°. 2, 3, and 4, the arſenick was in like manner precipitated. N°. 2 ſeemed even clearer than before the addition of acid.

7. Nitrous acid being added, in the ſame proportion with the vitriolic, the colour of all the oils was inſtantly changed to a dark brown, except the ſpermaceti-oil, which was not much affected; the train and linſeed oils ſuffering the greateſt change. In all of them a ſlight effervefcence took place.

8. Marine acid occaſioned a precipitation, which ſoon rediſſolved, in all of them.

9. Both the fixed alkalies immediately coagulated the oils; the water, in which the ſolution of alkali was made, ſubſiding to the bottom of the veſſel, along with the arſenick.

10. Three ounces of ſpermaceti-oil were digeſted with one drachm of litharge, during ſix hours, in about 200° of Fahrenheit. The oil became much clearer than before the experiment, but not near ſo colourleſs as when treated with arſenick: the litharge was changed to a white

colour.

colour. Part of the oil being poured off, and the heat afterwards increased, it soon became thick and high coloured.

11. Linseed-oil, exposed to the same degree of heat, under similar circumstances, underwent the same changes.

12. Train-oil was little affected in low degrees of heat, but, in higher degrees, became disco-loured.

13. A few drops of vitriolic acid being added to a portion of N°. 10, before the heat had been increased, the litharge was precipitated, and the oil left pure and clear, though not quite colourless.

14. Vitriolic acid being added to the linseed and train oils, N°. 11 and 12, a very small preci-pitation of the litharge took place; probably ow-ing to the heat not having been sufficiently great to dissolve it in large quantities, which had been found to be the case with the same oils, when di-gested with arsenick.

15. Nitrous acid, when added, instantly changed the colour of all three (N°. 10, 11, and 12,) to a dark brown; N°. 11 and 12 became thick and glutinous.

16. Marine acid precipitated the litharge. Upon being left to stand, the linseed and train oils assumed a much darker hue than they had previous to the addition of the acid.

17. Alkalies coagulated the oils, as in the for-mer experiments with them.

 18. Two

18. Two ounces of ſpermaceti-oil and half a drachm of red-lead, were digeſted during eight hours. The oil ſeemed not in the leaſt changed; but a ſmall quantity of the lead remained ſuſpended, and gave it a ſlight pink caſt. The heat, the next day, was gradually increaſed, with as little ſucceſs, till the oil was brought to nearly a boiling heat; it then became dark and diſcoloured.

19. Linſeed-oil was tried in the ſame proportion, with the like reſult.

20. Train-oil was treated in the ſame mode as the others, with one drachm of red-lead. On increaſing the heat, it formed a very thick dark coloured maſs.

21. White-lead, and the oxide of copper which is formed upon the diſtillation of acetated copper, had the ſame effect with the red-lead. But leſs of the oxide of copper appeared to be diſſolved than of the oxides of lead.

Not meeting with the ſucceſs I was at firſt led to expect, from the digeſtion of the oils with the metallic oxides, I ſubmitted them to the action of different pure aërated earths, under the ſame degrees of heat.

22. Two ounces of ſpermaceti-oil and one drachm of the earth of alum, precipitated from a ſolution of alum by the vegetable fixed alkali, were placed in a ſand heat, of from 180° to 190° of Fahrenheit, and ſuffered to remain there during

 three

three hours. The oil became clear and colourless, the gluten having precipitated with the earth to the bottom of the vessel.

23. Two ounces of linseed-oil and one drachm and a half of pure clay, were subjected to the same degree of heat as the spermaceti-oil. This oil likewise became very clear, and much less coloured: a considerable deposition of mucilage was observed upon the surface of the clay. The combination of the mucilage with the linseed-oil, appeared to be much stronger than that of the spermaceti-oil with its gluten.

24. Train-oil was likewise rendered much purer by digestion with the same earth; but was in no degree equal either to the spermaceti or linseed oils.

25. Both aërated and pure magnesia precipitated the mucilage whilst the oils continued warm; but, as they cooled, the mucilage and magnesia rose, and mixed again with the oils.

26. Ten grains of pure calcareous earth being added to one ounce of each of the oils, in the cold, turned them thick, and dark coloured.

27. Aërated calcareous earth had little effect upon the oils, either heated or cold.

In all these experiments with the earths, not the smallest particle seemed dissolved, as, on the addition of any of the acids, they instantly changed to a very dark colour. Those oils to which

which the nitrous acid was added, became much darker than thoſe in which the metallic oxides had been digeſted, and to which the ſame addition had been made.

It is well known, that oils obtain the property of drying more quickly, by being boiled, either alone, or in conjunction with metallic oxides, and argillaceous earths. Oil, according to M. Lavoiſier, conſiſts of hydrogen or the baſis of inflammable gas, and carbone, the baſis of carbonic acid or fixed air. The metallic calces conſiſt of the metal united to oxygen or the baſis of pure air. According to this ſyſtem of chemiſtry, the metal, when boiled in oil, gives up oxygen to it, while the mucilage of the oil unites to the metal. It ſeems therefore probable, that in high coloured oils the carbone is ſuperabundant; and that, by digeſting the calces of metals in a lower degree of heat, a part of the oxygen of the calx may combine with the ſuperfluous carbone, and, forming carbonic acid, tend to diveſt the oil of its colour; while the oxide, attracting the mucilage, may contribute to the ſame end.

How far this theory may apply to the explanation of the foregoing experiments, I do not pretend to determine. It is remarkable, however, that one of the earthy ſubſtances, *viz.* the alumine, which is not known to contain either oxygenous or carbonic gas, decoloured the oils

more powerfully than moſt of the metallic oxides, and equally with any of them. This earth has a ſtrong attraction for colouring matter, and on this property depends its uſe in dying.

But, on the ſuppoſition that the above theory is juſt, it may be expected, not only that oils may be deprived of colour, but that rancid oils may be reſtored to ſweetneſs, by the metallic oxides. My father formerly found * that rancid oil, expoſed to ſtreams of carbonic gas, was ſweetened. The ſame effect may be produced by the ſame gas, formed in the proceſs; and indeed, though I was not particularly attentive to this circumſtance, I thought the train-oil was diminiſhed in rancidity; and the ſpermaceti-oil, which was kept for ſeveral months after expoſure to heat, continued ſweet.

Another circumſtance, worthy of remark, is, that though concentrated vitriolic acid, on addition to oils, blackens them, and gives out a ſulphureous ſmell; yet, when dropped into oils in which the metallic calces have been digeſted, it combines with the calces, and precipitates them, without either diſcolouring the oils, or changing their odour.

* Henry's Experiments and Obſervations, page 139.

XVII.

XVII. *Continuation of M.* Ribaucourt's *Observations on the Composition of Writing-Ink.*

(From Page 70.)

It is said, that sulphate of iron causes those stuffs which are dyed with it to feel rough to the touch, and that it also corrodes them. Should not these defects be rather attributed to the first coarse precipitate already spoken of?

Its coarseness is sufficient evidence that it cannot penetrate to the internal pores of the fibres of the wool. It appears that all it can do is, to attach itself to their surface, and to lodge itself, as it were, in the intervals left in the texture of the cloth; and that it wears them, on account of its hardness. For, if we admit, as we cannot help doing, that the sulphate of iron has been decomposed, and that its acid is saturated with the gallic earth, we can no longer consider it as being capable of corroding the stuffs which are dyed with it.

The fineness of the two following precipitates, and particularly of the third, which is also of a blacker

blacker colour than the two first, seems to me also to explain why the black dye used by hatters (which, with respect to the proportions of its ingredients, is, as M. Berthollet has remarked, rather an ink than a dye) will not dye silk at first, but dyes it very well, after a certain number of hats have been passed through it.

I shall not enter more largely into this subject; it is sufficient for me to have pointed out in what manner my discovery may be applied to the theory of dying black. By attentively considering the matter, assisted by the excellent observations of M. Berthollet, which agree perfectly well with mine, it appears to me easy to form an exact idea of the effect of galls on the sulphate of iron, in the black dye; not only when that dye is applied to wool, but also when it is applied to silk: and I think, that we may perhaps be able to apply that dye to thread and cotton, with more effect than has hitherto been done, and without being obliged to have recourse to a solution of iron in vinegar.

The discovery of the forementioned earthy salt in galls, serves to explain the effects they produce when they are used in preparing wool, silk, thread, and cotton, for the black dye.

I shall now return to ink, and shall give my opinion respecting the theory of the phænomena which take place in the decomposition of sulphate of

of iron by galls. By taking the weight of my three precipitates collectively, and comparing their colours, I hope to be able to ſhew, that all the acid of the ſulphate of iron was united to all the gallic earth; and that all the oxide of that metallic ſalt was precipitated of a black colour, by the colouring matter of the galls: in ſhort, that ink owes its colour to this precipitate, which is not diſſolved, but merely ſuſpended, in the liquor.

But, before I enter into this explanation, I think it proper to make ſome preliminary obſervations.

In the firſt place, it muſt be remembered, that the decoction of one pound of galls, when a ſolution of potaſh is poured into it, gives ſix ounces of earth.

Secondly, that ſix ounces of oxide are alſo obtained from one pound of ſulphate of iron, treated in the ſame manner.

Thirdly, that water alone, when employed in ſufficient quantity, decompoſes ſulphate of iron. Experience has ſhewn me, that ſix hundred and eighty parts of water completely decompoſe one part of this metallic ſalt.

Now it appears, that my three precipitates, when united, weighed eighteen ounces; and the precipitate which I obtained from two ounces of each of theſe ingredients, weighed eighteen drachms.

From this calculation it follows, first, that the six ounces of gallic earth, in combining with the sulphuric acid, absorbed six ounces of it, with which they formed a selenite, the greater part of which was immediately precipitated, on account of its insolubility in water; for it appears, that there remained in the liquor only half an ounce, or one twenty-fourth of the whole.

Secondly, that the second and third precipitates consisted of oxide of iron, almost pure; being united only to the fore-mentioned small portion of selenite, and to the colouring-matter of the galls. The appearance of these precipitates, and their different degrees of friability, even inclined me to believe that the latter was entirely free from it; but I did not make any experiments to determine the matter.

The different degree of intensity I observed in the colour of the precipitates, is very important, and helps to confirm what I have here advanced.

The greyish-blue colour of the first precipitate shews that it consists only of selenite, which has taken that colour because it was deposited in a coloured liquor; and also because it has, in its precipitation, carried off a small portion of coloured oxide of iron.

As the second precipitate is of a purplish-blue colour, and the third of a blue more inclining to black than the second, I conclude that the latter is the most pure; since it is only oxide of iron which

which receives the black colour from galls: and I suppose that the others are more blue, merely because they are composed of black and white, or that their blackness is more diluted.

M. Monnet examined the precipitate of sulphate of iron by galls, or, to use his own words, by the astringent principle; he found it to be of a very beautiful dark-blue colour, and thinks it might be advantageously made use of in painting.

Although the formation of the first precipitate may be easily explained, by the union of the sulphuric acid with the gallic earth, from which there results a selenite that is insoluble in water, that is by no means the case with respect to the two others. I first explained them, by the decomposition of the new ferruginous gallic salt by water; but, having more fully considered this explanation, I thought that the colouring-part which had combined with the oxide of iron, might also be one of the causes of its precipitation, in concurrence with the former.

I thought I could not better endeavour to clear up this doubt, than by attempting the decomposition of sulphate of iron by pure water alone; and, after seeking to determine the exact proportion of water requisite for that purpose, I found, as I have already stated, that one part of this salt could not be completely decomposed, by less than six hundred and eighty parts of pure water.

 Comparing,

Comparing, afterwards, the precipitate formed in the manner just mentioned with the third of those produced by means of galls, I observed that the one obtained by water only was of a yellow colour, dissolved easily and completely, (with effervescence, but without the assistance of heat,) in the nitric, sulphuric, and acetous acids, particularly before it had been dried; whilst the other, which, as I before observed, was of a blackish colour, was not attacked by those acids, unless assisted by heat, and was only partially dissolved therein, with great difficulty and slowness.

The colour of the first precipitate, the ease with which it was dissolved in a new acid, and the effervescence which accompanied its dissolution, persuaded me that it had been separated from its acid by a superabundant quantity of oxygen, which it had taken in the water; and I also thought it fair to suppose, that the other had, on the contrary, been precipitated by a superabundant quantity of phlogiston, which the colouring principle of the galls had given to it: that is to say, that one had quitted its solvent, because the oxygen of the water had completed its calcination and dephlogistication, which the sulphuric acid had begun; and that the other had separated from its solvent, because it again met with the principle of inflammability in the colouring matter of the

galls:

galls; also that the iron was restored, and even surcharged with phlogiston; in short, that it was brought into a state similar to that in which it exists in Prussian blue.

The blue colour of my precipitates, and the phænomena which, as we have just seen, they present with acids, led me to perceive this analogy (and particularly that of the two last) with Prussian blue; to convince myself of it, I determined to expose them to a gentle fire, with an alkaline liquor.

The first precipitate, as soon as it was penetrated with this liquor a little warmed, effervesced pretty strongly, which announced the decomposition of the selenite; the liquor acquired a reddish hue.

The effervescence of the second was hardly to be perceived, and the colour of the liquor became more deep.

I observed no effervescence at all in the third, and the colour of the liquor was nearly as deep as that of the preceding.

I repeated the same operation upon the third precipitate, with ammoniac or volatile alkali; the phænomena were the same as before.

I then poured some drops of a solution of sulphate of iron upon these liquors, after they were filtered and diluted with water, and I obtained very beautiful Prussian blue.

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I had no longer any doubt respecting the analogy of my precipitates with Prussian blue; and the above fact confirms my theory. It was very clear, from these experiments, that the first precipitate was a selenite, as I had supposed, since it effervesced with alkaline liquors, and gave them but a very faint colour, in comparison of that from the two others. It appeared also, that the second precipitate still contained selenite, as it produced a slight effervescence; and that, if the third contained any of that substance, it was at least in very small quantity, since it caused no sensible effervescence. The intensity of colour was also in proportion to the degree of homogeneity of the matter of the precipitates.

Lastly, these experiments shew, that ammoniac may become saturated with Prussic acid, and form Prussian blue, in the same manner as takes place with potash and soda.

These facts being established, the phænomena respecting the decomposition of sulphate of iron, by a decoction of galls, explain themselves; so also does the cause of the black colour of ink, and that of the black dye.

As soon as a solution of sulphate of iron in water is mixed with a decoction of galls, the sulphuric acid acts upon the earthy basis of the gallic salt, and forms a selenite, which, being insoluble

luble in water, is precipitated. On the other hand, a portion of the oxide of iron, being quitted by its folvent, charges itfelf with the colouring matter of the galls, and, on account of its great lightnefs, remains fufpended in the liquor, which it renders opaque, and of a black colour.

Laftly, the gallic acid either diffolves a part of the fuperfluous oxide of iron, or elfe remains free in the liquid; for, according to what I have before obferved, there is no probability that it can poffibly act upon the iron, which is fatu-rated with colouring matter.

This explanation will be ftill farther confirmed by fubfequent experiments.

Of the Effect of Campeachy or Logwood, with refpect to black Colours in general, and particularly with refpect to Ink.

Lewis confiders logwood as a very ufeful ingredient in making ink, the colour of which, he fays, it very much improves, without giving it a difpofition to fade.

He fays alfo, that fulphate of iron and galls, in whatever proportions they are employed for making ink, produce only different fhades of brown, but that logwood gives blacknefs to the liquor.

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A decoction of logwood contains no salt with an earthy basis, as a decoction of galls does; it is, therefore, not by decomposing sulphate of iron, by this principle, that the logwood acts in producing a black colour, but by charging the oxide of iron with its colouring matter, (which it is known to contain in great abundance,) in a degree to which we cannot arrive without its assistance, except by very much augmenting the quantity of galls; too great a proportion of which, as we shall see hereafter, is detrimental to ink.

I have said, that a decoction of logwood contains no salt with an earthy basis; I shall now prove that it does not.

If, into a decoction of two ounces of this wood, a solution of two ounces of sulphate of iron be poured, and the mixture be then diluted with water, so that the whole quantity of liquor consist of forty pounds, after standing twenty-four hours, a precipitate of a purple colour, very much inclining to black, will be produced, weighing three quarters of an ounce; the liquor above the precipitate will have intirely lost its colour.

The weight of the precipitate, which is only that of the oxide contained in two ounces of sulphate of iron, shews that no selenite is formed in this operation; consequently, that the decoction

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of logwood has not precipitated this oxide by the action of an earthy substance upon the sulphate of iron; but merely by the action of its colouring matter, joined to that of the water.

I say that the colouring matter has concurred with the water in causing the precipitation; because, if there had not been a great quantity of water, a part only of the oxide would have been precipitated; if the quantity of water had been very small, there would have been scarcely any precipitate.

If this experiment be repeated, with the addition of two ounces of galls to the fore-mentioned quantities of logwood and sulphate of iron, the precipitate will weigh two ounces and a quarter; that is, will weigh no more than that obtained from a mixture of similar quantities of galls and sulphate of iron, without any logwood; but it will be more black than that from those two ingredients alone.

Logwood, therefore, acts upon sulphate of iron in a different manner from galls. Its effect is, to furnish to the oxide of iron a great surcharge of colouring matter; which, by rendering it insoluble in acids, forces it to quit the sulphuric acid, and, at the same time, hinders it from being acted upon by the gallic acid. This acid otherwise would not fail to redissolve it, (at least in a quantity proportioned to its action, and its degree

gree of concentration,) when it became separated from its first solvent.

Logwood very much improves both the beauty and the colour of ink, for many reasons.

First, because the precipitate which it forms with sulphate of iron is more black than that formed by galls.

Secondly, because the oxide of iron must be more black, in proportion as it is more charged with colouring matter.

Thirdly, because, in consequence of what has been above stated, the oxide of iron is more disposed to quit its solvent, and less disposed to be redissolved by the gallic acid, in proportion as it is more surcharged with colouring matter: now, if the oxide of iron were dissolved by any kind of acid, the solution would be transparent; it would neither have the opacity, nor the colour, of ink. No solution of any salt is opaque, nor is any solution of iron of a black colour; these properties of ink are therefore owing to the separation of the oxide from its solvent, and to the suspension of its precipitate in the liquor.

Lewis adds, that logwood improves the colour of ink, without disposing it to fade. He might have said, that it not only does not dispose the colour to fade, but that it preserves it; since the more the oxide of iron is charged with colouring matter, the more it is enveloped and preserved from

from the action of the air; from which it follows, that it keeps its blacknefs better, when applied upon paper.

Confequently, logwood is a very ufeful ingredient in ink; and thofe inks which are made without it have neither the blacknefs nor the permanence of colour which form the principal perfections of this liquor. Yet, notwithftanding thefe advantages, it is an ingredient in very few of the *formulæ* for ink: I have found it in none but in Lewis's.

It is impoffible, however, to make ink with logwood alone; becaufe, as this wood does not furnifh any falt with an earthy bafis, it would not decompofe the fulphate of iron in fuch a manner as to produce a fufficient quantity of black precipitate; and, more efpecially, becaufe it would not furnifh a bafis with which the fulphuric acid could unite, which acid, remaining free in the liquor, would act upon the paper and corrode it.

Of the Effect of Sulphate of Copper (blue Vitriol) upon Ink.

Sulphate of copper is ftill lefs frequently ufed in making ink than logwood. Amongft a great number of *formulæ* that I have collected, I have

found but one in which it entered; and yet it may be employed with great advantage, not, as many persons (according to Lewis's account) have recommended, in place of sulphate of iron, but joined with it. This is contrary to Lewis's observation, who says that different proportions of pure sulphate of copper, added to the sulphate of iron, produced inks which were not equal to those prepared with the latter substance only.

The effect of the sulphate of copper upon the black colour is, to make it more dark, and to render the colour permanent. This last mentioned property of preparations of copper was known to the antients: it is called by them *coloris alligatio.*

There is no doubt that sulphate of copper is of great advantage to ink; and, if Lewis found that it was detrimental to it, it was probably because he made use of too great a proportion of it.

Of the Effect of Acetite of Copper (Verdegris) upon Ink.

Some persons, probably because verdegris renders black dyes more deep, have thought right to use a certain quantity of it in their compositions for ink; but the black colour produced thereby,

thereby, which appears to be permanent upon wool, is, as Lewis has obſerved, apt to fade when applied upon paper. The colour of the ink is indeed much more dark when the writing is firſt made; but it is not permanent, and grows ruſty much ſooner than when verdegris is not made uſe of.

It may perhaps be aſked, if the uſe of ſulphate of copper tends to fix the colour of ink, and even to ſtrengthen it, why does not the acetite of copper produce the ſame effect?

The reaſon is, that the firſt, being ſoluble in water by itſelf, does not interfere with the affinities of the acids to the earthy and metallic ſubſtances of the other ingredients, and that it is decompoſed by the ſame cauſes, and at the ſame time, as the ſulphate of iron; alſo, that the two oxides are precipitated together and unite; whereas the copper of the verdegris can only be partially precipitated, with the coarſer particles. It is probable that nothing is decompoſed by the water, except the ſalt formed of that portion of oxide of copper which is kept in ſolution by the acetous acid; the precipitate of which is too ſmall in quantity to produce the effect expected from it.

Verdegris, therefore, ought not to be uſed in making ink, ſulphate of copper being preferable to it.

On the Effect of Gum.

Gum is an eſſential ingredient in the compoſition of ink: its effect is, to give conſiſtence to the fluid, and to keep in ſuſpenſion the ferruginous precipitate; either by preventing it from forming in particles ſufficiently groſs to fall to the bottom by their own weight, or by retarding the fall of the particles after they are formed.

It alſo hinders the ink from ſpreading on the paper; ſo that every ſtroke of the pen depoſits a greater quantity of black matter, and conſequently a greater body of colour.

It likewiſe prevents the ink from ſinking into, or paſſing through, the paper.

And it envelops the colour in a kind of varniſh, which not only covers it, and defends it from the acceſs of air, but alſo gives it a ſhining appearance.

All the *formulæ* preſcribe gum-arabick; but every other kind of gum (even thoſe from our own trees) may be uſed in its place. Gum, of one kind or other, is neceſſary, whatever the other ingredients may be.

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On the Effect of Sugar.

Authors are not ſo well agreed on the neceſſity of the uſe of ſugar, in the compoſition of ink, as on that of gum; it enters, however, into a great number of *formulæ.*

Sugar is much leſs efficacious than gum, either in enveloping the colour, or in preventing its precipitation; it even haſtens the precipitation of ſome portions of the colour, and renders the ink very ſlow in drying. The ſhining colour it gives the ink does not compenſate for theſe defects; indeed gum makes it ſhine almoſt as much.

It is therefore not in order to envelop the colour, nor to prevent its precipitation, that ſugar is made uſe of in the compoſition of ink; it has certainly neither of theſe properties, both of which belong to gum.

There is hardly any doubt that it haſtens the precipitation of ſome portions of the colour; and it is ſtill more certain that it makes the ink dry with difficulty; this effect, however, does not take place to any great degree, unleſs too large a quantity of ſugar be made uſe of.

In ſhort, it is not ſugar, but gum, that is the proper ingredient to give a ſhining quality to ink. The effect of ſugar is only to make it flow

more freely from the pen; and, if it has been found necessary to increase the quantity of the sugar, in those inks which were desired to shine very much, it was because a great quantity of gum was put into them, and therefore sugar was found necessary, in order to make them flow.

Upon the whole, sugar may be considered as an ingredient necessary to the perfection of ink.

On the Effect of Alum.

Of all the ingredients that have been made to enter the composition of ink, there is not one which is so prejudicial to the beauty of its black colour as alum; the effect of this salt being always to change the black colour, more or less, to purple.

Alum, therefore, ought to be excluded from the composition of ink.

TO BE CONCLUDED IN OUR NEXT.

XVIII.

XVIII. *List of Patents for Inventions, &c.*

(Continued from Page 72.)

Robert Johnson, of Greek-ſtreet, Soho, in the county of Middleſex, Chemiſt and Apothecary; for a medicine, (known by the name of Whitehead's Eſſence of Muſtard,) for the cure of rheumatiſms, and other complaints. Dated March 30, 1798.

William Deverell, of Widcomb, in the county of Somerſet, Millwright; for a new-invented pump, or pump-work. Dated April 5, 1798.

William Sellars, of the city of Briſtol, Manufacturer of Spinning-Machines; for a new invention in making and working machines for preparing and ſpinning wool, cotton, flax, hemp, and various other materials. Dated April 18, 1798.

Francis Hollick, of Birmingham, in the county of Warwick, Curry-comb maker; for a new-invented art of affixing, in ſeveral ways, an iron or other comb to the edge, or on the outſide,

outside, of a curry-comb. Dated April 18, 1798.

John Edwards, of Bristol, Mathematical Instrument maker; for an apparatus of mathematical instruments, for the better ascertaining the geographical position of vessels at sea. Dated April 18, 1798.

Thomas Rowntree, of Great Surrey-street, Blackfriars-Bridge; Engine maker; for a method of applying fire, for the purpose of heating boilers and other vessels where heat is required. Dated May 1, 1798.

Joseph Bramah, of Piccadilly, Engineer; for an improvement in locks for doors, cabinets, &c. and also in the keys by which they are locked and unlocked. Dated May 3, 1798.

John Daniel Belfour, of Elsineur, in the kingdom of Denmark, Merchant; for improvements in the operation or working part of a machine formerly invented by him, for making and manufacturing ropes and cordage. Dated May 3, 1798.

Peter Boileau, of Bruton-street, in the parish of St. George, Hanover-square; for manufacturing straw into hats, bonnets, and other articles, in a manner, and to produce an effect, never before attempted. Dated May 3, 1798.

REPERTORY

OF

ARTS AND MANUFACTURES.

NUMBER LI.

XIX. *Specification of the Patent granted to* MATTHEW BOULTON, *of Soho, in the County of Stafford, Esquire; for his Invention of improved Apparatus and Methods for raising Water, and other Fluids.*

WITH TWO PLATES.

Dated Dec. 13, 1797.

TO all to whom these presents shall come, &c. Now KNOW YE, that in compliance with the said proviso, I the said Matthew Boulton do hereby describe and ascertain the nature of the said invention, and the manner in which the same is to be performed, as follows; that is to say, for the more clear description of the said invention, it is proper to state its physical principle of action, as follows: First, when water moves or runs through

through a pipe, or clofe channel, or tube, if the end at which the water iffues be fuddenly ftopped, the water will (by its acquired motion, momentum, or impetus,) act upon the fides or circumference of the pipe; which being fuppofed ftrong enough to refift that impetus, the water will iffue, with violence or velocity, at any aperture which may exift in or near the fhut-end of the pipe; and, if to that aperture an afcending pipe be joined, a portion of water will rife in it.

Secondly, if a pipe, open at both ends, with an afcending pipe, fuch as has been defcribed, be moved along, through ftanding water, in the direction of its length, upon fhutting the hinder part of the pipe, a portion of the water will rife in the afcending pipe, in the manner which has been ftated in the former cafe, becaufe the water is relatively in motion, in refpect to the pipe.

Thirdly, if, in either of the cafes recited, a pipe communicating with water at any lower level be joined to the main-pipe, at or near the end at which water enters into it, and if, when fuch water has acquired motion relatively to that pipe, (by the pipe being put in motion,) the mouth or end at which the water enters is fuddenly fhut, the water, continuing its motion relatively to the pipe, will draw or fuck up water from the lower level, through the afcending pipe, in order to fill up the vacuity occafioned by the water in the main

main pipe's persevering in its previous motion. What has been said respecting water, is also true in respect to other fluids.

The several cases above stated are resolvable into the general principle of the resistance which water and other fluids (and in general all bodies) make to a change of their state of rest, or motion, whether absolute or relative; and this principle has heretofore been applied to the raising of water, only, in a comparatively small and weak degree, and in a defective manner. But the improved apparatus I am about to describe, in the several methods hereinafter specified, (excepting the several cases of the sixth method hereinafter mentioned,) continue their own action when once set a going, unless some accident should stop or derange them; and are capable of raising water in great quantities, and to great heights, except as to great heights in some few of the cases hereinafter specified and explained; and also differ, in other respects, from any thing which has been executed hitherto.

The nature of the said improved invention consists in using valves, of various constructions, instead of cocks, to open or shut the end or ends of a main pipe, as hereinafter described, and in the application of mechanism or contrivances to assist in opening and shutting the valves at proper times; whereby, and by the methods

hereinafter ſpecified, water is raiſed, independently of any power other than a current of water through the main pipe, and the mechaniſm aforeſaid, except the ſixth method as aforeſaid; in which latter method ſome power is neceſſary to put the water in the main pipe in motion, (abſolutely or relatively,) as hereinafter deſcribed; and alſo in uſing proper materials for conſtructing the pipes, (as hereinafter mentioned,) in order to prevent the ſhock ariſing from the reſiſtance aforeſaid from cauſing the pipes to burſt; which latter circumſtance is eſſentially neceſſary to be attended to.

The manner in which the ſaid invention is to be performed, and the ſaid improved apparatus and methods carried into effect, is as follows, *viz.*

The firſt and moſt ſimple method is ſhewn in Fig. 1, (Plate VIII.) in which C C is the main pipe. DD the aſcending pipe. A the valve of exit for the water to be raiſed. B the ſtop-valve; and E a weight, which, by the lever F, attached to the axis G of the ſtop-valve B, opens it at the proper time. The ſaid apparatus acts in the following manner. The main pipe being ſituated or fixed in a current or ſtream of water, either produced by the natural current or declivity of a river or other ſtream, or (which is preferable) by penning up water by a dam, weir, or bank, and by

by inserting the end of the main pipe through the said dam, weir, or bank, so as to obtain the greatest head or current of water the natural circumstances admit of, the stop-valve being opened to the position shewn in the figures, the water will run through the main pipe, until, by its action upon the stop-valve, in its reclined position, it raises the weight, and shuts the stop-valve, and the water, by its impetus or momentum, opens the exit-valve, and a portion of it rises in the ascending pipe; after which, the last mentioned valve shuts, the water in the main pipe recoils, the weight descends and opens the stop-valve, and the water in the main pipe regains its velocity. The like operations are repeated, and the water gradually rises in the ascending pipe, until it reaches its summit, and a quantity issues thence every stroke; which quantity is more or less, according as the height to which it is raised is less or greater.

This first method is not eligible where the water is to be raised to any considerable height; for the natural fragility, or imperfection, of even the best materials that can be procured for forming the pipes, causes a great danger of the rupture of the pipes, in this form of construction, unless the raising of the water be limited to the height of a few feet, or unless the pipes be made of an extraordinary thickness, disregarding expence.

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This danger of burfting the pipes is to be regarded, in every cafe of applying this invention to practice.

The fecond method is fhewn at Fig. 2, and is adapted to the raifing of water to great heights as well as fmall. It differs from the former, in having an air-veffel or refervoir of air J, whereby the burfting of the pipes is prevented, or the danger thereof much diminifhed. Into this air-veffel, the water from the main pipe enters through the exit-valve, and compreffes the air in the veffel; which again, by its expanfion or elafticity, acts upon the water, (the regrefs of which is prevented by the fhutting of the exit-valve,) and the water rifes through the afcending pipe, and, by repeated ftrokes, acquires the defired height.

The dimenfions of the air-veffel, as well as its form and pofition, whether above, or laterally affixed to the main pipe, are in great meafure arbitrary; but its contents of air ought not to be much lefs than ten times the quantity of water to be raifed through the afcending pipe each ftroke, and if very much larger ftill the better, the principal boundary being expence.

The ftop-valve may be opened and fhut, as has been defcribed in the firft method, by the mechanifm fhewn in the fecond figure, or by any of the mechanifm hereinafter defcribed as adapted to the opening of valves.

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The third method is ſhewn at Figs. 3 and 4, annexed, and is applicable in caſes where the water to be raiſed is below the level of the main pipe, and is to be diſcharged at that level; which caſes occur in the drainage of marſhy lands, where the action of the current of water of an embanked river, or other ſtream or ſource of water on a higher level, can be employed; or this method can be applied in raiſing water out of the holds of ſhips, or other veſſels, by the motion of the veſſel through the water.

This is explained by Figs. 3 and 4; where C is the main pipe. A is the receiving-valve. B the ſtop-valve, opening outwards. D the aſcending or ſucking pipe. J the air-veſſel; and E the weight. The water in the main pipe having acquired a proper velocity, the ſtop-valve ſhuts: the water in the main pipe, continuing its motion for a time, draws air out of the air-veſſel. Then, the momentum of the water in the main pipe being expended, the receiving-valve ſhuts, and the ſtop-valve opens, the water regains its velocity, and the operation is repeated; and thus, in a few ſtrokes, (the exhauſtion encreaſing,) the air-veſſel ſucks up water from below, by the aſcending pipe; and this being continued, the latter pipe fills, by degrees, to the top; after which, at every ſucceſſive ſtroke, a portion of the water from below paſſes into the main pipe, and is carried off, with the upper water, to the place of delivery.

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The fourth method is ſhewn at Figs. 5 and 6; in which caſes, the tide, or other alternating current, is employed as the power, and applied to the raiſing of water, for the uſe of ſalt-works, or for other uſes.

This is done in two ways, either by applying a ſtop-valve, air-veſſel, &c. to each end of the main pipe, as in Fig. 5, to be uſed alternately, according as the tide ſets in the one direction or the other; or by applying two main pipes to one air-veſſel, as in Fig. 6, and to be uſed alternately, as aforeſaid.

The fifth method is ſhewn in Figs. 7 and 8; in which the main pipe C C C is bent in form of a ſyphon, to paſs over ſome obſtacle, ſuch as a low hill, or eminence, not higher than thirty feet above the ſource. In Fig. 7, the water raiſed is ſuppoſed to be delivered at the exit-valve A, on a level with the upper part of the bend of the ſyphon, and the ſtop-valve B is placed at the entrance of the air-veſſel.

The air-veſſel is introduced, becauſe, without it, the water in the leg C X would move only by ſtarts, and, by being ſuddenly ſtopt in its motion, would act violently in ſhutting the ſtop-valve; but, by the intervention of the air-veſſel, the water will run in C X nearly in a continued ſtream, while it runs in an interrupted one in the leg C C. It is neceſſary, in this form of conſtruction,

ſtruction, that the exit-valve ſhould be placed under water, contained in a box or ciſtern, leſt air ſhould enter.

In the ſyphon, Fig. 8, the ſtop-valve is fixed at the bottom or lower end of the delivering-leg C X; and, when that valve ſhuts, the water is diſcharged into the air-veſſel J; whence it aſcends, by the pipe D D, to the deſired height.

The ſyphon may be ſet to work, either by pumping out the air, or by ſhutting both its ends and filling it with water, (as is uſual in ſuch caſes,) when, the ends being opened, it will immediately ſet to work.

The ſixth method relates to ſuch applications of the above-mentioned general principle of reſiſtance, (or *vis inertiæ,*) as require the co-operation of ſome independent or extraneous power, to put the water of the main pipe in motion; abſolute or relative.

Figs. 9, 10, 10 (*a*), 11, and 11 (*a*), (Plate IX.) ſhew ſome applications of this method, in lieu of pumps, for raiſing water.

Fig. 9, C C, is the main pipe, bent in a ſpiral form round the air-veſſel J: it may either touch it, or be kept at a diſtance from it, and makes one or more revolutions round the ſaid veſſel. The whole of the main pipe is immerſed in the external water to be raiſed; one end is open to it, and the other has a valve opening in-

wards; and, near this latter end, a communication is made, by a ſide-pipe and exit-valve, with the air-veſſel. The whole turns on a pivot K; and the aſcending pipe D ſerves as an axis, which is kept upright by a collar, in which it turns, at L. Upon this axis is fixed a toothed wheel M, which is put in motion by another wheel N, turned by a winch, crank, or other contrivance. At the top or upper end of the aſcending pipe, the water is diſcharged into a trough, which ſurrounds it, and conveys it to the place of its deſtination. This apparatus is made to raiſe water by a continued rotative motion, the open end moving firſt; for whenever, by that motion, the main pipe has attained a proper velocity, the ſtop-valve ſhuts, and water paſſes into the air-veſſel, and the regreſs of the water is prevented by the ſhutting of the exit-valve; the ſtop-valve then opens, by means of a ſpring: the apparatus continuing to revolve in the ſame direction, more ſtrokes are made, at intervals proportioned to the velocity with which it moves. The ſpring ſhould be adapted ſo as not to prevent the relative motion of the water in the main pipe from ſhutting the ſtop-valve at proper intervals.

Figs. 10, and 10 (*a*), ſhew two conſtructions of this apparatus, in which the main pipe is made to vibrate round an axis, backwards and forwards; the

the limits of the vibration or ſtroke being determined by a detent T ſtriking againſt a ſtiff ſpring S. In Fig. 10, the main pipe and the air-veſſel are placed, not only out of the water to be raiſed, but at the height to which the water is to be raiſed, and the aſcending pipe has its foot immerſed in that water; but this conſtruction ſhould not be applied, in caſes where the water is to be raiſed much more than twenty-feet. C C is the main pipe, bent in a circular form round the air-veſſel J; at or near each end of which is a ſtop-valve B, opening outwards; and alſo a pipe or communication to the air-veſſel, with a receiving valve A, opening towards the main pipe. D is the aſcending pipe: at O is a valve, opening upwards, in order that when the aſcending pipe is filled with water it may be retained. The perpendicular ſection of the main pipe is drawn circular, but may be ſquare, or any other convenient form; and a horizontal ſection of it, with its ſtop and receiving valves, is ſhewn in the plan and ſide-view annexed.

Upon the aſcending pipe or axis D, is fixed a double pulley P, about which are wound the ropes Q, R; by the pulling of which, alternately, the apparatus may be made to revolve in either direction. The main pipe and the aſcending pipe being filled with water, by hand or otherwiſe, if the ropes Q, R, are pulled, alternately,

with ſufficient velocity, that is, if the apparatus makes about thirty vibrations in each direction in a minute, it will act well.

At Fig. 10 (*a*), the main pipe and air-veſſel are placed near the bottom of the aſcending pipe, ſo as that the main pipe may be wholly immerſed in the water to be raiſed: ſtop-valves are placed at each end of the main pipe, as in the laſt figure, only they open inwards; and pipes or openings are made to communicate between each end of the main pipe and the air-veſſel, having exit-valves opening towards the air-veſſel. The ſame letters, in this figure, are put on parts that bear the ſame name as in Fig. 10, except that A, in this, is an exit-valve; and the apparatus may be wrought by the ſame means.

At Fig. 11, the main pipe C C is made in form of the ſegment of a circle, of which the aſcending pipes D, D, are radii; or it may be ſimply a ſtraight tube, pipe, or trough, forming the chord to ſuch ſegment. The whole is moveable upon an axis U, at the centre of the ſegment. S, S, are two ſtiff ſprings, which regulate the length of the ſtroke; which, if wrought by the power of men, acting at the circumference of the ſegment, may be about three feet in each direction. At O O are valves, opening upwards, to retain the water in the aſcending pipes when filled. The main pipe C C, and the aſcending pipes D, D,

being

being filled with water, if the apparatus is pulled forcibly, first in one direction, and then in the other, it raises water from below; because, when it strikes either of the springs, the water in the main pipe, persisting in its motion, is partly thrown out, into the trough placed to receive it, and more water ascends through the ascending pipe, to supply the vacuity which would otherwise be formed.

In Fig. 11 (*a*), is represented an apparatus wherein the principal parts are in a position inverted, in comparison with those of Fig. 11; and the letters in this figure are placed on parts bearing the same name, except A, which in this case is an exit-valve. The whole of the main pipe should be immersed in the water to be raised; and then it may be made to raise water by such like means as are mentioned for the apparatus Fig. 11.

Every apparatus before described as belonging to the sixth method, admits of being put in motion by fire or steam-engines, or by water-wheels, or wind-mills, as well as by men, or horses, or other animals; and their sizes and dimensions are, in such cases, proportioned to their use, and to the nature of the power which works them.

The first, second, and third methods, above described, may be employed to raise water by the

the motion of the waves of the ſea, or of any large piece of water; in which caſe, the mouth or receiving end of the main pipe ſhould be formed like a ſpeaking-trumpet, and placed oppoſite to the direction in which the waves beat upon the ſhore at the place. The water of the waves will enter the main pipe, and ruſh through it until the ſtop-valve ſhuts; when the contained water will in part enter the air-veſſel, as has been deſcribed, and the next wave will produce another ſtroke.

When this apparatus is to be actuated by the waves of water, or the open current of a river, eligible forms of the main pipe are ſhewn at X, in Figs. 1 and 2, in the annexed figures.

The dimenſions of the ſeveral parts of the apparatus, in each of the ſeveral methods herein deſcribed, muſt vary according to the velocity and quantity of water paſſing through the main pipe, the height to which the water is required to be raiſed, and the quantity wanted to be raiſed in any given time. Proper materials for the main pipes and air-veſſels are, caſt iron, hammered iron, or copper, or braſs, or other hard and ſtrong metals, or mixtures of metals. For moderate heights and bores, wooden pipes would anſwer, and the better if ſtrongly hooped. Strong earthen pipes, of moderate bores, would anſwer for ſmall heights.

The

The valves and their mechanism are described as follows.

B, Fig. 1, is a common stop-valve, moving upon an axle, or hinge, and assisted to open, at the proper time, by a weight attached to a lever fixed to its axis, at the proper angle; which construction has been delineated as applied to the several varieties of the apparatus herein before explained, though the following kinds are also applicable.

The weight must be adjusted by experiment, so as to open the valves at the due times, according to circumstances; which may be done, either by sliding the weight nearer to, or further from, the centre of motion, or by encreasing or diminishing the weight itself. The inconvenience of this method is, that the weight being generally under water, it is troublesome to adjust it; therefore the mechanism in Fig. 12 is adapted to the stop-valve. The weight E is fitted upon a lever F, connected with a spindle J, to which the arm or lever G is also fixed; and that is connected, by the rod H, with the arm K, fixed to the valve. The rod H may be prolonged to any necessary length, and the weight and its mechanism may be always placed above water, so as to be easily come at, for adjustment. Valves of this kind are hinged, either upon their lower or upper edge, or upon one of the perpendicular sides, as a common door, according as conveniency requires,

quires; and the mechanism is connected accordingly.

Fig. 13. is another construction of the stop-valve, which is circular, and, instead of being hinged upon one side, is fixed upon a spindle in its centre, which slides in a socket or sockets, and, at the proper time, is opened by mechanism similar to the former here delineated, only, in place of the weight E, a spring is employed, which is also applicable in other cases.

In cases where the shock from shutting the stop-valve might derange the machine, some of the following valves are preferable to those before described.

Fig. 14. is a stop-valve which opens in two leaves, like the gates of a canal-lock: the leaves may shut upon one another in the middle, or may shut upon an upright bar placed there, as represented in the horizontal section and front-view; and they are opened by the same kind of mechanism as hath been described before, only there must be two connecting rods, one to each leaf of the valve. The aperture for this valve is of a rectangular figure. A valve in two leaves may also be hinged in the middle of the opening, but would too much obstruct the water-way. When the main pipe is of a large diameter, (two feet or upwards,) the stop-valve may be made in three, four, or more leaves, connected together by mechanism, as in Fig. 15, where an iron

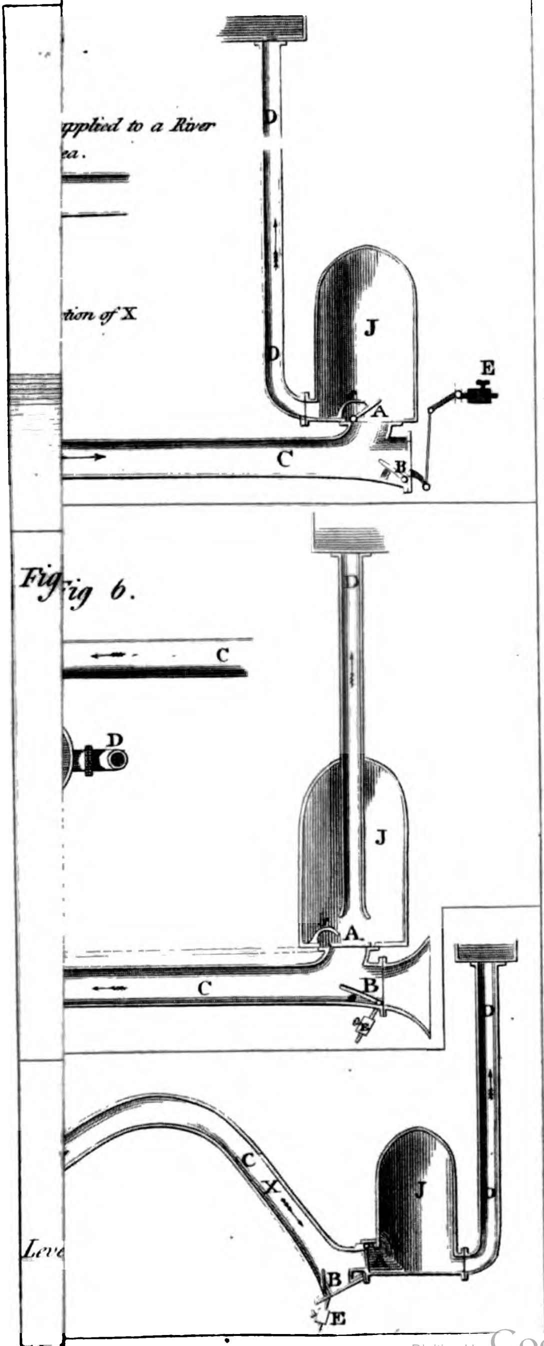
grating or frame is represented for supporting the valves; and mechanism, of the same kind as that described for the more simple valves, is applied to open them.

At Fig. 16. is delineated a valve turning upon an axis, like a common fire-stove chimney-damper: the axis does not pass through its centre, but divides it into two unequal segments. The valve is not opened so far as to stand in the line of the current of water, but stands, when opened, inclined to that current; so that the larger segment being placed towards the stream, the latter may, by its action, shut it at the proper time, and it is opened by mechanism similar to that described: any other species of valve, which is capable of being shut by the current and opened by mechanism, or opened and shut by mechanism solely, at the proper times, will answer this purpose. When the stop-valve is required to open so completely that the current of water in the main pipe cannot act upon it so as to shut it, a small stream of water is led from the head which supplies the main pipe, or from some other source, in a pipe or trough, which is furnished with a cock, shuttle, or other contrivance, to regulate the quantity. This pipe or trough pours its water into the bucket E, of the contrivance Fig. 17, which causes the bucket to preponderate, and, by means of the lever fixed to its axle, and the rod attached to it, shuts the stop-

ſtop-valve: the bucket then empties its water, and the weight F, as ſoon as the recoil of the water in the main pipe takes place, preponderating in its turn, opens the valve, and reſtores the bucket to its place. By opening the cocks more or leſs, and by the capacity of the buckets, in proportion to the weight F, the number of ſtrokes to be made in any given time is regulated. Excepting the laſt mentioned ſtop-valve, Fig. 17, all the ſtop-valves before deſcribed, ſhould be prevented from opening to ſuch a degree that the action of the current of water could not ſhut them. This may be done by ſome fixed reſiſtance behind the valves, as ſhewn at Fig. 1, and ſeveral other figures, or by any other convenient means.

When this invention is made uſe of in an open river, which does not admit of having its water penned up by a weir or dam head, the main pipe ought to be laid ſo as to be covered by the low waters of the river; and it ought to be parallel to the ſurface of the river, ſo as to have the greateſt poſſible declivity that can be obtained in the length of the main pipe: its mouth or receiving end ſhould be ſhaped like that of a trumpet, or bell. In all caſes whatſoever, the valves ought to be compleatly under water, otherwiſe ſome air will enter at every ſtroke, and derange the operations of the apparatus. In witneſs whereof, &c.

XX.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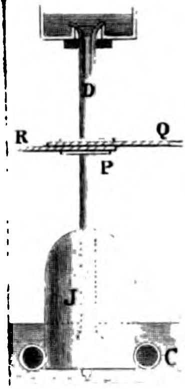
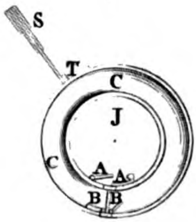


Fig. 10. (a)



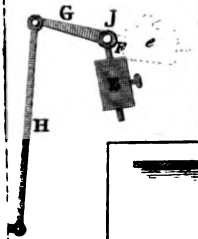


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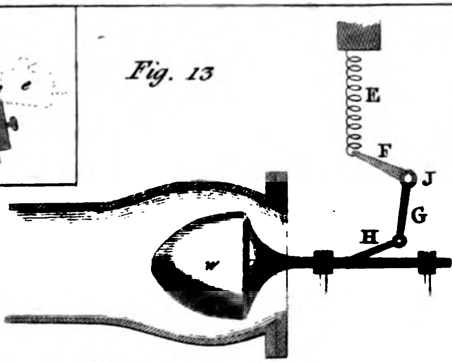
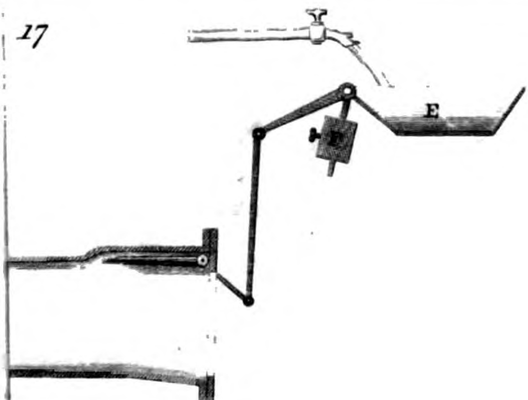
Fig. 13



w. Wood. c. Copper.

17



XX. *Specification of the Patent granted to Mr.* JOSEPH BARTON, *of the Parish of St. Botolph, Bishopsgate, in the City of London, Chemist; for an improved Method of preparing Indigo for the Purpose of dying Wool, Silk, Linen, Cotton, and other Articles, and Goods made and manufactured of the same, and for giving the Blue Shades to all Kinds of Linens, Woollens, Papers, and other Substances, in a more perfect Manner than hitherto discovered.*

Dated March 25, 1797.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Joseph Barton do hereby declare, that my said invention is described in manner following; that is to say, in consequence of the infinite variety in the quality of indigo, it is wholly impossible to state the quantity of the different materials necessary in the processes of the preparation; these must, in a great measure, depend on the quantity of colouring principle

contained in the indigo acted upon. The indigo being ground as fine as poſſible, and its quality, as to quantum and colour, aſcertained, by its perfect ſolution in acid or alkaline ſolvents, a ſufficient quantity of tin, iron, zinc, or alum, or all or any of them combined, to give a fixing baſe to the colouring matter of the indigo, is added; carefully neutralizing any ſuperabundance of ſolvents uſed in diſſolving the indigo and metals; which would otherwiſe injure the durability and the beauty of the colour, and render it more difficult of combination with other colours and ſubſtances uſed in dying, and preparing goods for that purpoſe; for the powerful acids, or alkalies, neceſſary to diſſolve indigo, deſtroy many, and injure nearly all, dying drugs or materials. In witneſs whereof, &c.

XXI. *Specification of the Patent granted to Mr.* Robert Johnston*, *of Greek-street, Soho; for his Invention of a Medicine which he calls* Improved Eſſence of Muſtard.

Dated March 30, 1798.

TO all to whom theſe preſents ſhall come, &c. Now know ye, that in compliance with the ſaid proviſo, I the ſaid Robert Johnſton do hereby declare, that my ſaid invention is deſcribed in manner following; that is to ſay, take the whole plant and root of the white and brown muſtard, and the white and brown muſtard-ſeed, any quantity; and, with a ſufficient quantity of water, diſtil therefrom the eſſential oil. Put this eſſential oil, with an equal quantity of the eſſential oil of juniper and the pureſt alkohol, into a retort; and, with as gentle a heat as poſſible, draw it over, and keep it very cloſely ſtopped. Digeſt cloves in freſh quantities of pure alkohol, ſo long as they afford any flavour: filter it, put it into a cucurbit, and diſ-

* This name is, by miſtake, printed Johnson, in our laſt Liſt of Patents, page 143.

til

til off the ſpirit, till it begins to thicken; to this reſiduum add a proper quantity of diſtilled water, and it will precipitate; divide this precipitate into flat cakes, and dry it with a gentle heat. Digeſt gum guaiacum in the pureſt alkohol; filter it; diſtil off a part of the ſpirit till it begins to thicken; precipitate with water, and dry it in the ſame manner. Take of the above preparation of cloves 1 lb. 3 oz. the preparation of guaiacum 2 lb. 7 oz. balſam of Peru 1 lb. 5 oz. balſam of Tolu 1 lb. 9 oz.; intimately mix the whole together, and ſtiffen it ſo as to form a hard maſs with Ruſſia caſtor, powdered; with which caſtor three drachms of the above eſſence of muſtard is to be mixed: to each pound of this maſs, ſix drachms of genuine Kermes mineral is to be added, and then formed into pills. Take brown muſtard-ſeed 96 lb. pour thereon 40 gallons of eſſential oil of turpentine, boiling-hot; let it ſtand till cold, and then put it all into the ſtill, with a ſufficient quantity of water, and draw 39 gallons: to this add 2 lb. of animal-oil, or oil of hartſhorn, (rectified by repeated diſtillations in a retort, till diveſted both of colour and ſmell,) 50 lb. of camphor, 4 lb. of eſſential oil of roſemary, 4 oz. of eſſential oil of cloves, ½ lb. of Engliſh oil of lavender, and ſix drachms of the above eſſence of muſtard. In witneſs whereof, &c.

XXII. *Specification of the Patent granted to Mr.* JAMES BURN, *of Alnwick, in the County of Northumberland, Hatter; for his Invention of a Compoſition for the making of Hats.*

Dated March 2, 1792.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that I the ſaid James Burn, in compliance with the ſaid proviſo, do hereby deſcribe and aſcertain the nature of my ſaid invention, and declare, that my new compoſition for the making of hats conſiſts of the following particulars, in the proportions following; that is to ſay, three ounces and an half of mole fur, two ounces and an half of rabbits wool, one ounce of beaver, and a quarter of an ounce of Aleppo wool; and, in order to ſubdue the obſtinate nature of the mole fur, ſo that it may incorporate with other furs uſually made into hats, I uſe a little aqua regia; but, as that proceſs deſtroys the elaſtic quality of the fur, I correct it by a little ſweet or Florence oil, which ſheaths the pungent points of the aqua regia. With this preparation, I make hats of the fineſt quality. In witneſs whereof, &c.

XXIII.

XXIII. *On the Usefulness of washing and rubbing the Stems of Trees, to promote their annual Increase. By* Robert Marsham, *of Stratton, in the County of Norfolk, Esquire, F. R. S.*

From the Philosophical Transactions of the Royal Society of London.

I HAD for several years intended to put in practice the celebrated Dr. Hales's advice of washing, with that of Mr. Evelyn of rubbing, the stem of a tree, in order to increase its growth; but other avocations prevented me till the last spring, when, as soon as the buds began to swell, I washed my tree (a beech) round, from the ground to the beginning of the head, *viz.* between thirteen and fourteen feet in height. This was first done with water and a stiff shoe-brush, until the tree was quite cleared of the moss and dirt, then I only washed it with a coarse flannel. I repeated the washing three, four, or five times a week, during all the dry time of the spring, and the forepart of the summer; but after the rains were frequent I very seldom washed. The unwashed tree, whose growth I proposed to compare with it,

it, was, (at five feet from the ground,) before the last year's increase, three feet, seven inches nine tenths; and in the autumn, after the year's growth was compleated, three feet, nine inches one tenth; *viz.* increase one inch two tenths. The washed tree was last spring three feet, seven inches two tenths, and in the autumn it was three feet, nine inches seven tenths; *viz.* increase two inches five tenths; that is, one tenth of an inch more than double the increase of the unwashed tree. As the difference was so great, and as some unknown accident might have injured the growth of the unwashed tree, I added the year's increase of five other beeches of the same age, (*viz.* all that I had measured,) and found the aggregate increase of the six unwashed beeches to be nine inches three tenths, which, divided by six, gives one inch five tenths and a half, for the growth of each tree; so that the gain by washing is nine tenths and a half. To make the experiment fairly, I fixed on two of my largest beeches, sown in 1741, and transplanted into a grove in 1749. The washed tree had been, from the first year, the largest plant, till the year 1767, when its rival became and continued the largest plant, until I began to wash the other; therefore I fixed on the less thriving tree as the fairest trial. The trees were nearly of the same height and shape, spreading a circle of about fifty feet diameter. I

 think

think it neceſſary to mention theſe circumſtances; for I know, by experience, that a ſhort and ſpreading tree, having ample room, will increaſe twice or three times, or perhaps four times, as much as a tall ſmall-headed tree, of the ſame age, that ſtands near other trees. Thus, my waſhed beech increaſed about ſix times as much as Mr. Drake's beautiful beech at Shardeloes, though that tree ſeemed in good health, when I ſaw it in 1759 and 1766. But it increaſed only two inches nine tenths in thoſe ſeven years; which may perhaps be owing to its vaſt height, being ſeventy-four feet and a half to the boughs, (as the late knight of the ſhire for Suffolk, Sir John Rous, told me Mr. Drake had informed him,) only ſix feet and four inches round, and having a ſmall head, and little room to ſpread.

Poſtſcript *. In my former paper I ſhewed how much a beech increaſed, upon its ſtem being cleaned and waſhed; and in this I ſhall ſhew, that the benefit of cleaning the ſtem continues ſeveral years: for the beech which I waſhed in 1775, has increaſed, in the five years ſince the waſhing, eight inches and ſix tenths, or above an inch and ſeven tenths yearly; and the aggregate

* The Poſtſcript was written ſome years after the preceding letter.

of

of nine unwaſhed beeches, of the ſame age, does not amount to one inch and three tenths yearly, to each tree. In 1776, I waſhed another beech, (of the ſame age, *viz.* ſeed in 1741,) and the increaſe in four years, ſince the waſhing, is nine inches and two tenths, or two inches and three tenths yearly; whereas the aggregate of nine unwaſhed beeches amounted but to one inch three tenths and a half. In 1776, I waſhed an oak which I planted in 1720, which has increaſed, in the four years ſince waſhing, ſeven inches and two tenths; and the aggregate of three oaks, planted the ſame year, (*viz.* all I meaſured,) amounted to but one inch yearly to each tree. In 1779, I waſhed another beech, of the ſame age, and the increaſe in 1780 was three inches; when the aggregate of fifteen unwaſhed beeches was not full fifteen inches and ſix tenths, or not one inch and half a tenth to each tree; yet moſt of theſe trees grew on better land than that which was waſhed. But I apprehend the whole of the extraordinary increaſe, in the two laſt experiments, ſhould not be attributed to waſhing; for, in the autumn of 1778, I had greaſy pond-mud ſpread round ſome favourite trees, as far as I ſuppoſed their roots extended; and although ſome trees did not ſeem to have received any benefit from the mud, yet others did; that is, an oak increaſed half an inch, and a beech three tenths, above

their ordinary growth. Now, though the beech gained but three tenths, yet perhaps that may not be enough to allow for the mud; for the summer of 1779 was the most ungenial to the growth of trees of any since I have measured them, some not gaining half their ordinary growth; and the aggregate increase of all the unwashed and unmudded trees that I measured (ninety-three in number, of various kinds) was, in 1779, but six feet, five inches and seven tenths, or seventy-seven inches and seven tenths; which gives but eight tenths and about one third to each tree; whereas, in 1778 (a very dry summer in Norfolk) they increased seven feet and nine tenths, or near eighty-five inches, which gives above nine tenths to each tree; and, in the summer of 1788, which was also very dry, the aggregate increase was above half an inch more than in 1778. But the greatest increase of these three years is low, as there are but twenty of the ninety-three trees that were not planted by me, and greater increase is reasonably expected in young than in old trees; yet I have an oak, two hundred years old in 1780 *, which is sixteen feet and five inches in circumference, or one hundred

* I cannot mistake in the age of this oak, as I have the deed between my ancestor Robert Marsham and the copyhold tenants of his manor of Stratton, dated May 20, 1580, upon his then inclosing some of his waste, and the abuttal is clear.

and

and ninety-feven inches in two hundred years: but this oak cannot properly be called old. The annual increafe of very old trees is hardly meafurable with a ftring, as the flighteft change of the air will affect the ftring more than a year's growth. The largeft trees that I have meafured are fo far from me, that I have had no opportunity of meafuring them a fecond time, except the oak near the Honourable Mr. Legge's lodge, in Holt Foreft, which does not appear to be hollow. In 1759, I found it was, at feven feet, (for a large fwelling rendered it unfair to meafure it at five or fix feet,) a trifle above thirty-four feet in circumference; and, in 1778, I found it had not increafed above half an inch in nineteen years. This more entire remain of longevity merits fome regard from the lovers of trees, as well as the hollow oak at Cowthorp, in Yorkfhire, which Dr. Hunter gives an account of in his edition of Evelyn's Silva, and calls it forty-eight feet round, at three feet. I did not meafure it fo low; but, in 1768, I found it, at four feet, forty feet and fix inches; at five feet, thirty-fix feet and fix inches; and at fix feet, thirty-two feet and one inch. Now, although this oak is larger near the earth than that in Hampfhire, yet it diminifhes much more fuddenly in girt, *viz.* eight feet and five inches, in two feet of height. (I reckon by my own meafures, as I took pains to be exact.)

Suppose the diminution continues about this rate, at seven feet (I did not measure it so high) it will be about twenty-eight feet in circumference; and the bottom fourteen feet contain six hundred and eighty-six feet round or buyers measure, or seventeen ton and six feet. Fourteen feet length of the Hampshire oak is one thousand and seven feet, or twenty-five ton and seven feet; that is, three hundred and twenty-one feet more than the Yorkshire oak, though that is supposed, by many people, to be the greatest oak in England.

I am unwilling to conclude this account of washing the stems of trees, without observing, that all the ingredients of vegetation united, which are received from the roots, stem, branches, and leaves, of a mossy and dirty tree, do not produce half the increase that another gains, whose stem is clean to the head only, and that not ten feet in height. Is it not clear, that this greater share of nourishment cannot come from rain? For the dirty stem will retain the moisture longer than when clean; and the nourishment drawn from the roots, and imbibed by the branches and leaves, must be the same to both trees. Then must not the great share of vegetative ingredients be conveyed in dew? May not the moss and dirt absorb the finest parts of the dew? And may they not act as a kind of screen, and deprive the tree

tree of that ſhare of ſun and air which it requires? To develop this myſterious operation of nature, would be an honour to the moſt ingenious, and the plain fact may afford pleaſure to the owners of young trees; for, if their growth may be increaſed by cleaning their ſtems once in five or ſix years, (perhaps they will not require it ſo often,) and if the increaſe is but half an inch yearly above the ordinary growth, it will greatly overpay the trouble, beſides the pleaſure of ſeeing the tree more flouriſhing. Although the extra increaſe of my firſt waſhed beech was but four tenths of an inch, the ſecond was nine tenths and a half, and the third near two inches; ſo that the aggregate increaſe is above one inch and one tenth yearly; and the increaſe of the oak is eight tenths. But, calling it only half an inch, ſix years will produce above five cubic feet of timber, as the oak is eight feet round, and above twenty feet long, and ſixpence will pay for the waſhing; conſequently, there remains nine ſhillings and ſixpence clear gain, in ſix years.

XXIV. *Farther Obſervations reſpecting the beſt Manner of planting Potatoes. By Mr.* JOSEPH WIMPEY, *of Bratton-Clovelly, near Okehampton, Devon.*

From the Letters and Papers of the Bath and Weſt-of-England Society for the Encouragement of Agriculture, &c.

I FORMERLY gave an account of an experiment made to diſcover whether whole potatoes or cuttings are to be preferred in planting *.

From that account it clearly appeared, that the advantage lay greatly on the ſide of cuttings. But as, from long experience, I know concluſions drawn from ſingle experiments cannot be ſafely depended on, and as the reſult of that experiment differed ſo widely from an account given by a very reſpectable correſpondent of the So-

* For Mr. Wimpey's former obſervations on planting potatoes, ſee our eighth volume, page 49.

ciety,

ciety, whose accuracy is well known, and of whose probity and veracity I have the highest opinion, I resolved to repeat my former experiment as exactly as possible, by way of establishing a fact so interesting to the public, if found just, or of retracting an error, if it should appear to be one.

In the spring of 1791, I prepared about three acres of ground, and in April planted it with potatoes. A certain quantity of the largest and finest were selected, one half of which were planted whole, the other cut into pieces of a moderate size. An exact account of each was kept at taking up, when it appeared that the produce *per* acre was much the same as in the former experiment; but, as the cut potatoes planted nearly four times the ground that the whole sets did, the advantage lay, in the same proportion, on the side of planting with cut potatoes; therefore I think there cannot be the least doubt that the preference is to be given to cuttings, as the success of the two experiments so nearly coincides.

I have been used for some years to furnish my neighbours with potatoes for planting. The last season, one of them desired I would let him have them all small. He said he had planted small ones several years, that he found them equally

 productive

productive with the largest, and saved much trouble in cutting. Others (who carried their œconomy much farther) preferred the largest; they, it seems, used to pare them, to eat the fleshy part, and to plant the rinds only. Upon enquiry, I found this was not an unusual practice among the cottagers; and, I have been credibly informed that they get as large crops, and as good potatoes, in that method of planting as in any other whatever. If this be a fact, it seems to appear, that the fleshy part of the bulb is of no use in supplying nourishment to the young fruit, after the fibrous roots have put forth, and laid hold of the ground. Perhaps an experiment of this sort may be thought worth making.

XXV. *Experiments and Obſervations on Fermentation, and the Diſtillation of Ardent Spirit. By Mr.* JOSEPH COLLIER.

WITH A PLATE.

From the MEMOIRS of the LITERARY and PHILOSOPHICAL SOCIETY of MANCHESTER.

WE may lay it down as an inconteſtible axiom, ſays Lavoiſier, that in all the operations of art or nature nothing is created. An equal quantity of matter exiſts, both before and after the experiment: the quality and quantity of the elements remain preciſely the ſame; and nothing takes place, beyond changes and modifications in the combinations of thoſe elements. Upon this principle, the whole art of performing chemical experiments depends. We muſt always ſuppoſe an exact equality between the elements of the body examined, and thoſe of the products of its analyſis *.

* Elements of Chemiſtry.

The ſubject of fermentation, but more particularly the fermenting infuſion of malt, has been very little attended to as an object of chemical enquiry. Diodorus Siculus, Herodotus, and Tacitus, mention a method of making wine from malt; yet the modern world had made very little progreſs, either in improving the proceſs, or aſcertaining its products, until Dr. Prieſtley and the Duke of Chaulnes made their intereſting experiments, on the carbonic acid gas diſengaged during the operation of fermentation. Soon after theſe important diſcoveries were communicated to the public, the accurate philoſopher whom I firſt quoted, inſtituted a ſet of moſt valuable experiments on this ſubject; and from their reſults eſtabliſhed a firm baſe for farther enquiry. Before this period, all was undefined, and the chemiſt had nothing to direct his attention but ſcattered facts, many of which rather tended to confound than properly to conduct his inveſtigation.

The diſtillation of ardent ſpirit has met a ſimilar fate to that of fermentation. The Egyptians, at a very early period, diſcovered the art of drawing ſpirit from wine. Modern chemiſts have left it in the rude hands of the ill-informed, and accident has been the chief contributor to its improvement. It is true, that ſome of the proof ſpirits of commerce are pure and good; but this ariſes more from the nature of the wines from which

which they are drawn, than from the fuperior fkill of the diftiller. The fugar-cane and the grape are eafily attenuated by fermentation, and contain lefs fœtid oil than malt; neither are they fo liable to contract an empyreuma in the ftill. I was induced to begin this enquiry from a firm perfuafion, that it was poffible, by means of known chemical agents, to produce malt fpirit equally pure with that which is obtained from any other modification of faccharine matter; and moft of the following facts are confined to malt-liquor. Many other particulars have occurred, in the courfe of my experiments, which I thought worthy of notice, and which I fhall tranfcribe from my notes; but I fhall firft make a few obfervations on fermentation in general.

Fermentation is an inteftine motion in the folution of faccharine matter, whereby a new arrangement of its conftituent elements takes place, and alcohol is produced, without the intervention of any other agent, of any denomination whatever.

From the above definition it will appear, that I mean to exclude all operations from the denomination of fermentation, excepting that in which wine is produced, and, confequently, alcohol. Bellini fays, that all things are full of ferments; and Van Helmont affirms, that fermentation is the fole caufe of almoft every tranfmutation.

tion. But the excellent Boerhaave was aware of the confusion which was likely to arise from general terms, and, therefore, limited the word fermentation to three distinct operations: the formation of alcohol, the making of vinegar, and the production of ammoniac; since which, a vinous, an acetous, and a putrid fermentation have been generally acknowledged: the second as a consequence of the first; and the third as a consequence of the two former.

My present object is neither to enter fully into the investigation of acetous acid, nor of the cause of putrefaction; but I shall make a few remarks upon each.

To produce vinegar, (which is chiefly obtained from fermented liquor,) the presence of an acid is necessary, such as the *tartareous acidula*; but it may be obtained by other vegetable acids, as well as from gums and amylaceous fœcula dissolved in water. A heat of from seventy to ninety degrees of Fahrenheit's thermometer is also necessary to the production of vinegar; and fermented liquors will become acid, under this temperature, by the solution of the tartar only; yet a perfect vinegar cannot be formed in a close vessel. A free access of vital air is absolutely necessary to the production of acetous acid, but is highly injurious to the spirituous fermentation: add to this, that insipid mucilages or gums dissolved in water, become

come acid, without having been discernibly spirituous. Why then should the making of vinegar be called fermentation?

The production of ammoniac, which is called the putrid fermentation, arises from the texture of the solids being destroyed, and the nature of the fluids being altered; and it is a well-known fact, that many vegetable and other substances never undergo any sensible vinous fermentation, or are formed into vinegar, previous to putrefaction. In some of my experiments on the fermenting infusion of malt, I have observed a beginning putrefaction, without any previous acidity; which I attribute to an entire completion of the spirituous fermentation, whilst the air was excluded, and the heat never sufficient to dissolve the tartar. It has been before observed, that a heat of from seventy to ninety is required to form the acetous acid, but putrefaction will take place in a temperature of forty-five. The putrefaction of vegetables volatilizes and reduces them to an earthy state; but, to mark the phænomena of vegetable putrefaction, and to distinguish it from the putrefaction of animal matter, will form the subject of another essay; in which I shall endeavour to prove, that the production of nitre, and the formation of vegetable mould, might with equal propriety be called fermentation, as the production of ammoniac; both being products of putrefaction.

Fermentation

Fermentation muſt, therefore, be either conſidered as a general term, and ſuppoſed, according to the opinion of Van Helmont, to be the ſole cauſe of almoſt every tranſmutation; or it muſt be limited to expreſs ſome definite proceſs, by which one or more ſpecific products are obtained. In the latter caſe, the moſt common application will certainly be deemed the moſt proper, *viz.* the production of alcohol, by an inteſtine motion in the ſolution of ſaccharine matter, without the intervention of any other agent whatever.

Some chemiſts are of opinion, that inſipid or gummy mucilages, barley, &c. paſs by a ſort of fermentation into ſaccharine matter; but of this I ſhall ſpeak more at large, when treating on the ſubject of malting.

No other but ſaccharine matter is ſuſceptible of fermentation, and it is neceſſary to obſerve a proper proportion between the denſity of the liquor and the quantity of yeſt; for, although artificial ferment is not abſolutely neceſſary to produce fermentation, yet it has a tendency (as is well known) to accelerate its progreſs.

The heat of the liquor muſt alſo be regulated according to the denſity; as a greater or ſmaller degree of heat is excited during fermentation, according to the quantity of fermentable matter which the liquor contains.

The phænomena which accompany fermentation, together with many other interesting particulars, may be found in an ingenious essay on the subject, by Mr. Thomas Henry *. I shall, therefore, proceed to a description of the instrument by which I regulated the gravity of my worts.

The scale of my saccharometer corresponds to that of Blake's, but the form is materially different. It is so constructed, that a plate above the ball is sufficiently large to contain a scale of the intermediate gravities, including the strongest and weakest worts with which the experiments were made. It begins with 0, and proceeds by equal divisions to 80°; a density which cannot be properly attenuated, without repeated fermentations with large quantities of yest. In the middle of the plate stands a thermometer, graduated from 0 to 100°; the use of which will be explained by and by. The divisions in the scale were made on a supposition that malt was worth about two pounds the quarter; whereby every varying degree that should be found in two worts, where equal quantities had been drawn from two different kinds of malt, would indicate a difference in value, of so many sixpences.

* Mr. Henry's Essay is printed in our seventh volume, page 46.

The faccharometer ought to be accompanied by an affay-veffel, which is nothing more than a cylindrical jar of tin.

When it is to be ufed, fill the affay-jar with wort, and reduce it to fixty degrees of heat. Then leave the inftrument at full liberty, in the jar of wort, and it will reft at the proper degree of denfity, which will be found upon the fcale *.

If the liquor be not cooled to fixty degrees, one degree of denfity fhould be allowed for every additional five degrees of heat.

When the above regulations are attended to, the following will be found to be nearly the denfities or gravities of fome of the moft celebrated malt liquors, both before and after fermentation.

Porter has fixty-fix degrees of denfity before fermentation; but is reduced, by a proper fermentation, to twenty-fix degrees of denfity.

Ringwood ale, feventy-four degrees before fermentation; but is reduced to thirty after.

* I believe this faccharometer will be found pretty accurate; yet, "there are other principles in fluids befides their gravity, by which they refift the admiffion of a defcending body, and the firft of thefe is that of attraction; which, operating powerfully on bodies compofed of heterogeneous particles, muft have confiderable influence in fuch a fluid as wort. A tendency to coagulate in the higher temperatures, and an approach to congelation in the lower, are certainly co-operating principles in all gelatinous liquors." See the Appendix to Richardfon's Statical Eftimates.

Dorchefter

Dorchester ale, eighty-four before, and forty-five after.

Table-beer has forty degrees of density before fermentation, but only twenty-two after.

From the foregoing observations, the use of the saccharometer is sufficiently manifest: it not only serves as a guide to the quantity of liquor to be drawn from malts of different qualities, but also to determine whether those liquors are properly attenuated by fermentation.

The first part of the experiments is arranged in the following order.

I. On the production of artificial ferments, with a view to ascertain their relative values *.

II. Whe-

* Boerhaave arranges, what he calls principal ferments, in the following order. 1. All those things which, of their own nature, are greatly disposed to ferment, so as immediately to begin this operation without any other ferment: such as the juices of ripe summer-fruits, which are so strongly disposed to ferment, as scarcely to be kept quiet without the help of things that prevent fermentation. So likewise a paste made of flour and water, and laid in a warm place, cannot then be hindered from fermenting. Hence, we need not be solicitous about a first ferment, because nature spontaneously affords it every where. 2. The recent flowers thrown to the top of beer, in the act of fermentation; for, if this rarified frothy matter be mixed with other fermentable liquors, it greatly promotes their fermentation. 3. The same matter, now become heavier, and sunk to the bottom, provided it be not too

II. Whether the fermentation ought to be carried on in open or close vessels.

III. The effects of different factitious airs on fermenting liquors.

I. From a considerable number of experiments on artificial ferments, I shall select the six following.

1. I took four ounces of wheat-flour, and a pint of water. The water, when mixed with the flour,

too stale, still retains the same virtue, though in a less degree than the former. In this state it is called lees; and, being by motion mixed with its own wine, it often occasions a new fermentation, and will excite it in other subjects. 4. Cassia, honey, manna, sugar, and the like inspissated juices. 5. Paste of flour fermented, or baker's leaven: for, though meal may be preserved for years, fresh and sweet, in a dry place, and kept from insects; yet, if wrought with water into a soft, sweet, and close paste, and lightly covered, in a warm place, it will, in an hour's time, begin to heave, swell, rarify, become all over full of cavities, change its smell, taste, and tenacity, prove acid both to the taste and smell, and thus become that proper ferment, which gave the original name of this whole operation; because, when thus prepared, if a part of it be mixed with other fresh paste, not yet fermented, it now causes it to ferment much sooner and stronger. 6. The remains of former fermenting matters, sticking to the sides of casks, every way penetrated by the subtilty of the wines they before contained, become extremely apt for raising quick and violent fermentation in fresh liquors put into them. 7. The white of eggs beat up to a froth, &c. See the Practice of Chemistry, p. 108.

was of about eighty degrees of heat, and the mixture was placed in a temperature varying from ſixty-five to ſeventy-five, for five days.

2. To a mixture ſimilar to the above, and of the ſame degree of heat, I added an ounce of muriat of ſoda, (common ſalt,) which was alſo left in a temperature varying from ſixty-five to ſeventy-five, for five days.

3. The ſame proportions of water and flour were mixed as in the firſt and ſecond experiments, and put into Nooth's apparatus, and ſubjected (as in Mr. Henry's Experiments) to the action of the carbonic acid gas, for five days.

4. A quart of ſtrong infuſion of malt * was placed in the ſame temperature, for an equal length of time.

5. To

* The method propoſed by Mr. Maſon, (which is inſerted in the Tranſactions of the Society for the Encouragement of Arts, Manufactures, and Commerce,) is as follows:

" Procure three veſſels, of different ſizes or apertures; one capable of holding two quarts, the other three or four, and the third five or ſix. Boil a quarter of a peck of malt, for about eight or ten minutes, in three pints of water; and when a quart is poured off from the grains, let it ſtand in a cool place, till not quite cold, but retaining the degree of heat which the brewers uſually find to be proper, when they begin to work the liquor. Then remove the veſſel into ſome ſituation near the fire, where Fahrenheit's thermometer ſtands between ſeventy and eighty, and there let it remain till the fermentation

5. To another quart of malt-liquor, was added three ounces of a ſtrong infuſion of hops, and treated as before.

6. An equal quantity of the infuſion of malt was put into the middle part of Nooth's apparatus, and ſubjected (like the flour and water) to the action of the carbonic acid gas, for five days.

All the foregoing compounds began to ferment about the ſame time, (four days after the mixture was made;) but, in order more fully to aſcertain their real value, I took ſix veſſels, into each of which I put three gallons of wort, of forty-five degrees of denſity. One of the above ferments was put into each veſſel of liquor, and they were all placed together, in a temperature of fifty-one degrees, for eight days; at the end of which time, each parcel was ſeparately diſtilled; but the quantity of ſpirit obtained was ſo nearly ſimilar in all, that I have kept no account of their reſpective products. It muſt, however, be obſerved, that the quantity of ſpirit formed was much leſs than might have been produced by the aſſiſtance of a little yeſt. At the ſame time it is obvious, that

fermentation begins, which will be in about thirty hours; then add two quarts more of a like decoction of malt, when cool, and ſtir it well in the larger-ſized veſſel; then proceed as before; after which, add an equal quantity more, and mix all in the largeſt veſſel, and it will produce yeſt enough for a brewing of forty gallons."

fermentation

fermentation may be effected, by subjecting solutions of saccharine matter to a proper temperature, without the addition of an artificial ferment. This is a farther proof of Dr. Pennington's opinion, that worts would ferment without yest; though a much greater length of time is necessary, and after all the operation is not so perfect.

With respect to the doctor's opinion on the raising of bread, I think it is by no means conclusive. He takes a quantity of dough, and subjects it to the action of yest, for three quarters of an hour, and then commits it to distillation: he obtains some water, but no spirit; from which he concludes, that bread is not raised by fermentation. Had the doctor said that a complete fermentation was not necessary to raise bread, I should have had no objection to his hypothesis. An operation is certainly begun, which in nine or sixteen hours, according to his own experiments, forms a spirit. This observation was suggested on my first reading Dr. Pennington's Inaugural Dissertation; but, in order more fully to satisfy myself, I took a gallon of wort, to which I added, at a proper temperature, two ounces of yest. The mixture was made in a glass jar, and I observed all the signs of a beginning fermentation, such as a motion excited in the liquor, the bulk of which was increased, and rendered turbid by the appearance of opaque filaments, together with an increase

increase of heat. After it had stood three quarters of an hour, I distilled it, but not a drop of spirit came over. It may be urged, that this is only a negative fact; but, when we observe that a change is effected in the dough, similar to that in the fermenting malt-liquor, in an equal length of time; when we see the products of each turn out exactly alike; and when we consider that dough of itself ferments in a few days, without the addition of yest, we have, at least, presumptive evidence, that the raising of bread is a beginning of fermentation.

I have made some additional experiments, to produce artificial ferments from molasses, sugar, honey, and the expressed juice of ripe fruits; but, as I found them all much inferior to the flowers of wine, or common yest, my subsequent experiments were all assisted by the latter.

When I mention the quantity of yest used, I mean to be understood, one part of dry yest *, (dried upon canvas,) and seven parts of water.

* 2.7608507 lbs. of dry yest, consist of — —	Hydrogen -	.2900716
	Oxygen -	1.6437457
	Carbon - -	.7876519
	Azote - -	.0393815

Lavoisier.

TO BE CONCLUDED IN OUR NEXT.

XXVI.

XXVI. *Conclusion of M.* Ribaucourt's *Observations on the Composition of Writing-Ink.*

(From Page 142.)

On the different Liquors which have commonly been made use of in making Ink.

WATER, white-wine, beer, and vinegar, are the liquors which have been usually employed in making ink; every author having his own particular opinion respecting them, and recommending that which he thinks preferable, to the exclusion of the others: some use any of them indifferently. This is, however, by no means a matter of indifference: that liquor which can best extract the colouring matter, and dissolve the saline substances and the gum, and which joins to these properties that of having no immediate action upon the colour of the ingredients, must certainly be the most likely to produce an ink of the blackest colour, and one which will preserve that colour for the longest time. Now, I shall presently shew, that the other fluids above mentioned,

tioned, far from ſurpaſſing water in theſe reſpects, do not even equal it.

In the firſt place, thoſe inks which are made with white-wine, beer, or vinegar, are not more black than thoſe which are made with water; and, inſtead of their keeping good a longer time, I have aſcertained, by many experiments, that the writings of ink made with vinegar grow ruſty and yellow, while thoſe of ink made with water preſerve their original blackneſs.

It might indeed be ſuppoſed, that white-wine, and, ſtill more, that vinegar, would be preferable to water, becauſe their acid would ſeize upon the oxide of iron, as it quits the ſulphuric acid; probably it was on this account that they were prefered to water; but I have ſhewn, that the colouring matter which envelops the iron, renders it incapable of being acted upon by acids. I have likewiſe ſhewn, that the oxide of iron acquired a black colour, and formed ink, not as being diſſolved by an acid, but, on the contrary, as being precipitated from its ſolution. It is alſo an eſtabliſhed fact, that a ſolution of iron in the acid of vinegar, produces a very pale ink, the colour of which ſoon fades and diſappears; in ſhort, an ink of very little value.

I may add, that to put vinegar into ink, is to increaſe the quantity of free acid; and it is certainly to the action of the free acid in ink, aſſiſted

affifted by that of the air, that the alteration which takes place in the colour of writings is to be attributed. For it cannot be doubted, that the acid is concentrated by the drying of the ink, and that its action upon the black precipitate (which it finds in a ftate the moft favourable to its decoloration) is more powerful than when, being itfelf very much diluted, and confequently very weak, it meets the precipitate in a larger mafs, and defended from the contact of the air; confequently, in a ftate lefs fit to be acted upon. It is, therefore, not to be wondered at, that ink which is prepared with vinegar fhould appear as black, when ufed, as that which is prepared with water; and yet that the writing which is made with the firft fhould grow yellow, while writing made with the other preferves its black colour unchanged.

I have not obferved that beer contributes to the goodnefs of ink; on the contrary, I have remarked, that it renders it too thick, and makes it more liable to grow mouldy than when made with other liquors.

Water is, therefore, the moft proper liquor to be employed in the compofition of ink; and (whatever may have been faid to the contrary) every kind of water is fit for the purpofe; the hardeft water appears to be equally good as rain water, or even as diftilled water.

On the Proportions of the Ingredients which enter into the Composition of Ink; and, first, of those of Galls and Sulphate of Iron.

There is a great difference amongst authors, with regard to the respective proportions of all the ingredients which enter into the composition of ink.

Some of them prescribe six parts of galls to one of sulphate of iron; others recommend three parts of sulphate of iron to one of galls.

Thus, according to some, the quantity of galls ought very much to exceed the quantity of sulphate of iron; whereas, on the contrary, according to others, the quantity of sulphate of iron ought to exceed that of galls.

These differences are very considerable, and prove that no chemist, before Lewis, had seriously, and in a scientific manner, enquired into the composition of this useful liquor.

It is far from being true, that the respective proportions of these ingredients is a matter of indifference, either with respect to the beauty of the ink, or the durability of the writing made with it. It is to a neglect of scientific principles, that the public are indebted for such a variety of inks

inks of all kinds; of which some are very black, while others are very pale; and some preserve their blackness a considerable time, while others grow pale, rusty, or yellow, more or less quickly.

We have shewn, that the blackness of ink is principally owing to the oxide disengaged from the sulphate of iron by the earth of the gallic salt, and dyed by the colouring matter with which it is furnished by the extractive part of the galls; whence it follows, that if these two ingredients are not employed in just proportions, the ink cannot be perfect.

If there is an excess of sulphate of iron, its oxide will not be sufficiently charged with colouring matter; nor will it be so covered as to be defended from the action of the air, consequently the ink will soon grow rusty and yellow.

If there is an excess of galls, writing made with it will be more durable; but it will not be of a good black colour, and will have a tendency to change to a yellowish brown.

If the respective proportions of these ingredients are in a mean between these two extremes, the colour of the writing, and the changes it will undergo, will be governed by the properties of the prevailing ingredient, and will be in proportion to its excess.

This theory agrees with the experiments of Lewis; by which we are shewn,

1. That

1. That equal parts of galls and sulphate of iron produced an ink which had a good black colour; but that writing made with it, and kept covered up for some weeks, became of a yellowish brown; which change took place in a few days, when the writing was exposed to the sun and the air.

2. That when the quantity of sulphate of iron exceeded that of the galls, the change in the colour of the ink was more quick, and more strong, in proportion as the excess of the sulphate of iron was more considerable.

3. That when the quantity of galls exceeded that of the sulphate of iron, the colour of the ink was more lasting.

For instance, a mixture of two parts of galls with one of sulphate of iron, produced an ink which kept its colour better than one made with equal parts of each.

Whereas, by putting four, five, or six parts of galls, the colour of the ink was more lasting than that of the preceding, but it was not so black.

Lewis supposes, that the change which takes place in the colour of the ink is owing to the want of a sufficient quantity of galls; that, to render the colour of ink lasting, the quantity of galls ought not to be less than three times that of the sulphate of iron; and that it cannot much exceed this

this proportion, without prejudice to the blackneſs of the ink.

Upon this head I ſhall obſerve, firſt, that it appears, from what I have ſtated, that the change which takes place in the colour of ink, does not, as Lewis ſuppoſes, always ariſe from a defect in the quantity of galls, but may equally ariſe from an exceſs of that ingredient. It is indeed very true, that ink which has too ſmall a proportion of galls, either grows ruſty and yellow, or is of a yellowiſh-brown colour; but it is not leſs true, that ink which has too great a proportion of galls, never has a good colour, and that the writing made with it is of a brown or pale colour, according to the proportion of galls; and this paleneſs increaſes, in ſuch a way, that after a certain time, the writing becomes ſcarcely legible; and, although this change of colour may take place more ſlowly than that of the other, it is more complete, and more prejudicial; that of the firſt being of ſuch a nature, that the writing may be read a long time after the characters traced by the other are hardly to be diſtinguiſhed. An exceſs of galls, therefore, may produce a decay in the colour of the ink, of a worſe kind than that which is produced by the want of them.

Secondly, equal parts of galls and of ſulphate of iron, produce an ink of a good black colour, but which, when expoſed to the air, acquires a

yellowiſh-brown, and not that yellow ruſty colour which is acquired by thoſe in which the ſulphate of iron predominates; this proves, that the above-mentioned proportions come near to thoſe which are required to produce a good and laſting ink.

Thirdly, my experiments have ſhewn me, that two parts of galls to one of ſulphate of iron, are ſufficient to produce an ink capable of fulfilling, in a proper manner, thoſe purpoſes to which that fluid is applied; and that three parts of galls (which Lewis conſiders as the ſmalleſt proportion that ſhould be uſed) is too much, becauſe there then remains in the ink too great a quantity of gallic ſalt not decompoſed; this is afterwards decompoſed by the water, and its earth, in precipitating, carries with it a part of the colouring matter, and of the black oxide of iron: perhaps alſo the colouring matter of the ſuperabundant quantity of galls, injures the black colour of the ferruginous precipitate, giving it a brown caſt.

From all theſe obſervations, I think I have a right to conclude, that the reſpective proportions of the galls and the ſulphate of iron ſhould be ſuch, that the latter ſhould be entirely decompoſed, and that there ſhould rather be too great than too ſmall a quantity of the former; but this exceſs ſhould only be as much as is ſufficient to ſaturate

ſaturate the oxide of iron with colouring matter. It is, no doubt, with this view, that Lewis recommends three parts of galls to be uſed; but it is better to leave out one of thoſe parts, and to put, inſtead thereof, a ſufficient quantity of logwood; which would furniſh to the ferruginous precipitate a great quantity of colouring matter, and does not contain any ſalt with an earthy baſis, capable of rendering the ink liable to be afterwards decompoſed, ſince it increaſes the blackneſs of the precipitate, without adding to its weight.

On the Proportions of Sulphate of Copper.

The effect of ſulphate of copper being to render the colour brown, and to fix it, the quantity of it ſhould be properly limited: it appeared to me, that the beſt proportion was an eighth part, by weight, of the galls. A larger quantity renders the colour too brown, and a ſmaller one is not ſufficient to fix it.

On the Proportions of Gum and Sugar.

The proportions of gum and ſugar ſhould be regulated, not according to the quantity of galls, but according to that of the liquid.

My observations respecting the first of these subjects agree with those of Lewis. I found that the best proportion was, one ounce of gum to a quart of ink.

With respect to sugar, I found that two drachms and forty-eight grains was the best proportion for the same quantity.

On the Proportions of Liquid.

The proportions of liquid, relatively to the quantity of galls, vary very much in different formulæ. I have met with some which prescribe four parts of water to one of galls; other formulæ, and their number is still greater, require six parts. Lewis directs from eleven to sixteen parts of water.

I found that twelve parts of water to one of galls formed a very good ink.

Corollary.

By attending to what I have hitherto said, it will be seen, that galls and sulphate of iron form the bases of ink.

That logwood is a very useful ingredient, because its colouring part concurs with that of the galls to give a black colour to the oxide of iron; and

and becauſe it gives to the ink a more beautiful and perfect black colour; and to the writing, made with ſuch ink, a greater body or conſiſtence.

That the ſulphate of copper is uſeful for deepening the colour of the ink, and rendering it more permanent.

That the uſe of gum is indiſpenſable, to hinder the ink from ſpreading on the paper, and ſinking into it; alſo to give to the ink a greater body of colour.

That ſugar is neceſſary, to reſtore to the ink a part of that fluidity which gum, by itſelf, tends to take from it.

That the perfection of this liquor depends upon the reſpective proportions of the ingredients, either amongſt themſelves, or with the liquid made uſe of.

That water is the moſt proper liquid for the compoſition of ink.

Laſtly, that the effect of galls may be aſſiſted by the uſe of logwood; but that this latter, notwithſtanding its advantages, cannot ſupply the place of galls, as they form the eſſential baſis of ink.

On the Manner of operating upon the Ingredients, in order to make them into Ink.

Authors are divided in their opinion, whether it is best merely to infuse the galls in cold water, or to macerate them in warm water, or to boil them, more or less.

Some macerate all the ingredients together; others macerate or boil the galls first, and then add the other ingredients, either before the liquor is strained, or afterwards.

On this head I shall observe, first, that the object is not merely to extract the colouring matter of the galls, which might certainly be very easily done by means of cold water; but it is very doubtful whether we could, without the help of boiling, obtain a complete dissolution of the gallic earthy salt, which, however, is very necessary to the decomposition of the sulphate of iron. Besides, it is a known fact, that inks made with cold, or even with warm water, are pale when used, and do not become black till several days after; nor have they ever so fine a colour as those inks which have been prepared by being well boiled.

But, although it is necessary that the galls should be boiled, and also the logwood; that necessity certainly

certainly does not extend to the ſalts and other ingredients: to boil them is rather an inconvenience, it being, without doubt, much better to throw them into the decoction of the galls and logwood, after having ſtrained it.

Beſt Proportion of the Ingredients for the Compoſition of Ink.

Eight ounces of Aleppo galls, and four ounces of logwood, are to be boiled in twelve pounds of water, for the ſpace of an hour, or until half the quantity is conſumed.

The liquor is then to be ſtrained through a piece of linen, or through a hair-ſieve, into a proper veſſel, and, if the quantity is found to be as above directed, namely, ſix pounds, there may be added to it,

Four ounces of ſulphate of iron,
Three ounces of gum-arabic,
One ounce of ſulphate of copper,
One ounce of ſugarcandy,

The liquor is to be ſhaken, from time to time, to facilitate the ſolution of the ſalts, and more particularly that of the gum. When it is certain that all theſe are completely diſſolved, the whole may be left to ſtand quietly for twenty-four hours; after which, the ink may be decanted from

from the grofs fediment which is depofited at the bottom of the veffel, and may be kept in glafs or ftone bottles, well ftopped.

Obfervations.

This ink has a black colour, a little inclining to purple, in the bottles; but the writing made with it is of a beautiful black, and it preferves its blacknefs, without alteration, for a great length of time.

Each quart of this ink contains,

	oz.	drs.	grs.
Of galls, - -	2	5	20
Of fulphate of iron, -	1	2	40
Of logwood, - -	1	2	40
Of gum, - - -	1	0	0
Of fulphate of copper, -	0	2	40
Of fugarcandy, - -	0	2	40

Lewis ufes, in each quart,

Of galls, - -	3	0	0
Of fulphate of iron, -	1	0	0
Of logwood, - -	0	5	24
Of gum, - -	1	0	0

He ufes neither fulphate of copper nor fugar.

On

On the Preservation of Ink.

I have obſerved, that many perſons recommend putting iron, others recommend putting galls, at the bottom of the bottles in which ink is kept. I never put any thing in mine; and yet I never obſerved that it ſuffered any change in its colour, or any other injury, even after it had been kept a conſiderable length of time.

Thoſe who recommend galls for the abovementioned purpoſe, undoubtedly ſuppoſe, with Lewis, that the decay of ink is occaſioned by the want of a ſufficient quantity of that ſubſtance. But, beſides what I have already ſaid on this head, I muſt obſerve, that I cannot comprehend in what manner ſuch perſons ſuppoſe the defect in queſtion would be remedied by this addition. The colouring part of the galls is precipitated only by the oxide of iron; and the additional quantity of galls cannot hinder the precipitation of the black oxide: this precipitation is the cauſe of the alteration in the colour of the ink; which alteration, in this inſtance, takes place, not from any want of blackneſs in the precipitate, but becauſe it is diminiſhed in quantity; the addition of galls is therefore quite uſeleſs.

Putting iron at the bottom of the bottles may, at firſt, appear more advantageous; but ſome obſervations

observations upon that expedient, will shew that it is also an useless one.

The end proposed in this case is, to replace, by fresh iron, that which it was supposed the sulphate of iron would, in a certain time, let fall in the form of oxide; to the loss of which the alteration in the colour of the ink was attributed. But I must observe, first, that when this salt is used in a proper proportion, it is almost entirely decomposed by the gallic salt, at the very instant of its mixture with the galls. Secondly, that the sulphuric acid, when converted into selenite, is incapable of again dissolving iron. Thirdly, that the sediment of ink which has been long kept, is not an oxide of iron in the state of ochre, but a black precipitate, similar, in all respects, to that which remains suspended in the ink, and causes its blackness. Fourthly, that this precipitate would not be replaced by fresh iron; because the iron would not find in the ink that matter which is necessary to give it colour, even supposing that it found therein a free acid, capable of dissolving it, and afterwards a substance fit to produce the decomposition of the new salt which it had formed. In short, experience has convinced me, that ink may be preserved several years, in a state of perfection, without putting either galls or iron at the bottom of the vessels in which it is kept.

On the State of the Acids in Ink, and of the Attempts which have been made to saturate the Sulphuric Acid.

Lewis, suspecting that the loose sulphuric acid in ink was one of the principal causes to which its change of colour was owing, endeavoured to separate that acid by the addition of lime; but the ink was by no means mended thereby. A small quantity of lime did not much alter the colour, and a large quantity thereof turned it of a reddish-brown. Writings having been made with these mixtures, and exposed, for the space of two months, to the sun and the air, it was found that those which were made with the mixture which had the greatest proportion of lime were illegible, and the others had lost their colour more than if they had been made with common ink.

As the sulphuric acid is combined with the earth, in the form of selenite, there can be no loose acid in the ink but the gallic acid, the weakness of which is such as to leave no room to suppose that it can act upon the black ferruginous precipitate; there is consequently no reason why the saturation of the acids should be attempted.

On the Trials which have been made of various Ingredients, as Substitutes for Galls.

It has been attempted to supply the place of galls by different vegetable substances, most of them taken from the class of astringents: various solutions of iron have also been tried, as substitutes for the sulphate of iron; but experience has shewn, that these two substances are absolutely necessary in the composition of good ink.

The bark of the black-thorn or sloe-tree, the roots of tormentil, and of bistort, the flowers of the pomegranate-tree, and the rind of its fruit, have all been tried, but were found to give to the ink made with them more or less of a greenish hue; none of these ingredients were capable of furnishing that black colour which is obtained from galls.

Sumach, which in the black dye may be used instead of galls, gives to ink a greenish cast, which renders it an improper ingredient in its composition.

Oak-bark appears to give the same kind of black as galls; nevertheless, when it was used alone, it produced a bad kind of ink; and, even when the proportion of it was eight or ten times as great as the usual proportion of galls, it was very

very far from producing an equal effect. Saw-dust from oak-wood gives ink a very strong tinge of blue; which tinge it always retains, whatever proportion of oak saw-dust is used.

Various other astringents were tried, in conjunction with galls, and with logwood: they did not take from the colour of the ink, nor did they appear to add any thing to it.

Lewis tried the juice of privet-berries, of mulberries, and of black cherries: all these produced inks which appeared more full of colour than if made with water alone, but they were less black, and became dull and rusty after being kept some time.

On the Trials made with various Solutions of Iron, as Substitutes for Sulphate of Iron.

Solutions of iron in nitric and muriatic acid, produced inks which were too corrosive, and the colour of which was not sufficiently black; that made with muriatic acid inclining to blue, and that made with nitric acid being of a brownish-green.

A solution of iron in acetous acid, produced a very indifferent ink.

A solution of iron in acid of tartar, gave to the decoction of galls a reddish-brown colour.

A solution of iron in lemon-juice, has a better effect than that made with vinegar, but is still inferior to the sulphate of iron.

Conclusion.

The result of what has been said is, that ink is a compound liquor, which owes its blackness to the oxide of the sulphate of iron; which is disengaged from its solvent by the earth of the gallic salt, and coloured by the extractive matter of the galls: it remains in the liquid in a state of suspension, not of solution.

2. That hitherto no ingredient has been discovered, that can be properly substituted for galls, in the composition of ink.

3. That logwood assists the colouring action of the galls; that is, it renders the precipitate more black, without encreasing the quantity of it.

4. That sulphate of copper is advantageous, as it tends to fix the black colour of ink, without disturbing its composition.

5. That gum is useful in preventing ink from spreading on the paper, and sinking into it. By preventing its spreading, the characters traced with it are charged with a greater quantity of colouring matter. Gum also serves as a kind of varnish, to defend the ink from the action of the air; and

and contributes, in conjunction with the colouring matter of the galls, and that of the logwood, to prevent its decay.

6. That ſugar has the effect of reſtoring to the ink a part of that fluidity of which the gum deprives it.

7. That ſulphate of iron cannot have its place ſupplied by any other ferruginous ſalt.

From theſe obſervations it follows, that all theſe ingredients are neceſſary in the compoſition of ink; that their place cannot be ſupplied by other ſubſtances; and, that the perfection of ink depends on their being combined in juſt proportions.

And, although all the ingredients which enter the compoſition of ink alſo enter that of the black dye, it is by no means true that all thoſe which enter the latter compoſition are proper for making ink. Beſides, the proportions of them, either with reſpect to each other, or with reſpect to the liquid made uſe of, are not the ſame.

Yet, notwithſtanding the difference between theſe two compoſitions, the chief of the foregoing experiments and obſervations on galls, and thoſe on ſulphate of iron, may be equally applied to both of them.

Appendix,

Appendix, containing some Experiments relating to the Subject of the foregoing Dissertation.

Three ounces of sumach, and two ounces of sulphate of iron, produced (by treating the sumach in the same manner as the galls) an ounce and a quarter of precipitate. Two ounces of galls would have produced two ounces and a quarter of precipitate.

Four ounces of a solution of iron in vinegar, produced (by means of fixed alkali) two ounces and a quarter of precipitate.

Four ounces of a solution of iron in acid of tartar, produced (by means of fixed alkali) an ounce and a quarter of precipitate. Four ounces of sulphate of iron would have produced an ounce and a half of precipitate.

XXVII. *List of Patents for Inventions, &c.*

(Continued from Page 144.)

GEORGE BLUNDELL, of the parish of St. Matthew, Bethnal Green, in the county of Middlesex, Manufacturer; for a machine for the purpose of saving fuel, and preventing dirt or dust from fires, which he calls the *Œconomical-Receiver*. Dated May 3, 1798.

WILLIAM JONES, of the city of Bristol, Millwright; for a machine for the purpose of more readily mixing malt, or other substances, with fluids; whereby the essence or spirit of the malt, or other substances intended to be acted on by water, or other fluids, will be more perfectly and expeditiously extracted than by any other method hitherto invented. Dated May 8, 1798.

ROBERT FRITH, of Salford, in the county of Lancaster, Dyer; for a chemical method of dying different permanent colours upon cotton, linen, woollen, and silk. Dated May 25, 1798.

William Sanxter, of Horseheath, in the county of Cambridge, Farmer; for a plough for the paring of land, which he conceives will be of great public utility, and peculiarly calculated for the saving of manual labour. Dated May 25, 1798.

John Champion, of the city of Bristol, Manufacturer of Brass, Copper, and Iron Ware; for a method of making wire from rolled and slit iron, either foreign or English, put in operation by various powers. Dated June 2, 1798.

George Pomeroy, late of Boston, in North America, but now of London, Merchant; for an apparatus and machinery for the manufacturing of tobacco and snuff, and for other purposes. Dated June 5, 1798.

John Palmer, of Maxtock, in the county of Warwick, Yeoman; for a new invention in the construction of apparatuses used for clearing grain from the straw, and for pulverizing the same. Dated June 5, 1798.

Jonathan Hornblower, of the borough of Penryn, in the county of Cornwall, Engineer; for a machine or engine for raising water, and for various other useful purposes in arts and manufactures, by means of steam and otherwise. Dated June 8, 1798.

REPERTORY

OF

ARTS AND MANUFACTURES.

NUMBER LII.

XXVIII. *Specification of the Patent granted to Mr.* DAVID FREARSON, *of Liverpool, in the County of Lancaster, Merchant; for Machinery and Operations for the Purpose of saving Fuel, in the Process of evaporating Water from Solutions of Salts, the waste or cast-off Leys of Soap-makers, and which may be applicable on other Occasions, where Evaporation, or a Separation of Water, forming either wholly or in Part a dissolving Fluid, from the Substance or Substances held in Solution, is required.*

Dated May 21, 1792.

TO all to whom these presents shall come, &c. NOW KNOW YE, that the principles on which the patentee rests his pretensions to his Majesty's letters of licence, for an exclusive right to the practice and emoluments of his invention, are, generally

rally speaking, these. As oily, soapy, gelatinous, or mucilaginous matter, when intermixed with aqueous solutions, and gathering upon their surface, would materially obstruct the progress of evaporation, when promoted by the principles to be proceeded on, all such are to be removed, as much as is possible and convenient, by filtration, and, at proper periods during the process, to be skimmed off. After having, when requisite, undergone such filtration, for the forementioned purpose, or for removing other impurities which it may be desirable to separate, the solutions of salts, the waste or cast-off leys of soap-makers, or other mixed solutions, (from which water, forming either wholly or in part a dissolving fluid, is required to be evaporated or separated from the substance or substances held in solution, and with which a part of the substances intended to be left behind may occasionally fly off,) are to be exposed to the atmosphere, in shallow ponds or reservoirs, which are to have various machinery affixed to them; by means of which, a part of the solutions may be successively taken up, and spread over the surfaces of the machinery appropriated to that purpose, and thus have an increase, division, or extension of their surfaces farther exposed to the atmosphere, to be acted on by the sun and air, and are to be protected, by such machinery, from rain or dew falling

falling into, or incorporating with them. The operations and machinery he judges most proper to effect this purpose are as follows; and, though machinery of other forms and other materials than those he points out, may undoubtedly be constructed and contrived for the same use, yet, as they must assuredly be some way or other imitations of these, and operate upon the same general principles, he trusts and hopes that his study and expence to accomplish this business will not be suffered to be lost to him, by attempts to evade his patent on such grounds.

I. *The Receiving Reservoirs, for Solutions required to be kept or filtered.* The soap-makers waste leys, or any other solutions of such description, will require reservoirs for their reception, of dimensions proportioned to the quantity whence the water is required to be evaporated, and which, with the succeeding reservoirs, may be sufficient to contain a considerable portion during the winter, or any long continuance of wet unfavourable weather. These dimensions will necessarily be regulated by circumstances, such as, the extent of the reservoirs and machinery to which they are attached, the quantity likely to be received in winter, and during weather not favourable to the progress of evaporation, &c. They may be constructed of various forms and materials, but must be so tight as not to admit the solutions, in any

 material

material quantity, to penetrate or exude through them. If they are formed in the ground with clay and bricks, or clay, bricks, and cement, the best form will be cylindrical; the base of the cylinder will be parallel with the horizon. These I will call, to distinguish them from the others, *The Receiving Reservoirs.*

II. *Filtration, and the Filtering Reservoirs.* When any solutions require filtration, to take from them any obstructions to evaporation, or earthly impurities, there must be another reservoir constructed, similar to the former, and adjoining thereto, over which must be placed large square-edged bags or filters, fastened to cords at their edges; the bottoms of which, when suspended and containing the fluid, may incline towards a spherical or conoidical form, of a moderate depth. These square-edged filtering bags, formed of canvas, hair or other cloth, or stuff fit for the purpose, (into which the solutions must be pumped, or some other way run in,) must be secured, by nooses at the angles, to upright staffs or pegs, placed at the end of rods, running square with each other in an horizontal direction; from which, to the rods, the nooses may be at any time slipped, so that the two opposite points of each parallel side of the square (or it may be oblong) horizontal line of direction of the nooses upon the rods, may be brought or drawn to approach each other

other, and the residuum in the filters pressed. In addition to the above mode of filtration, he proposes (when the solutions are so impure as to require it) to divide these filtering reservoirs into two parts, by a partition; to put coarse sand at the bottom of each division, so as to occupy a space of some inches, left for the purpose, between the bottom of the dividing partition and the bottom of the reservoirs, and to come up a little above the bottom of the partition. The bottom of the division, over which the filtering stuffs are suspended, must decline a little towards the bottom of the other; and, upon the sand in the former, is to be placed coarse hair-cloth, canvas, or other stuff, fixed to poles, by nooses, with cords, so as to be drawn up at pleasure, and the residuum found upon it, after the solutions have passed into the other divisions, taken away. These filtering, as well as the receiving reservoirs, should have slight sheds or roofs, to keep out the rain. The soap-makers waste leys will particularly require as perfect a filtration as can conveniently be had; as the soapy and gelatinous matter they commonly contain, if not separated, will gather upon the surface of the solutions, and in a great measure retard the progress of the evaporation of the water. Other solutions, to which the principles of this patent are applicable, may also require an attentive filtration, as well as these.

III. *The*

III. *The Evaporating Reservoirs.* Either the solutions which have passed filtration, or those which do not require to be filtered, are to be run or pumped into shallow pits or reservoirs. These evaporating reservoirs are to range and be placed so as to extend from east to west, or nearly in that direction, in the longer or oblong side of their square, and from north to south in their shorter side or breadth; they may be from about nine to about fourteen inches deep, and are to be so constructed as to retain the solutions, and of such materials as may be had on the cheapest terms, and be effectual for the end in view, (as well as the other reservoirs before mentioned,) which will of course vary in different situations, circumstances, and places, respecting which, I shall endeavour to give some instructions, or at least hints, in my remarks on the materials.

IV. *The Materials of which to construct the Reservoirs in general.* There being a great variety of materials of which all the afore-mentioned reservoirs may be constructed, I shall endeavour to point out those which may be generally the cheapest and most fit. If good clay is to be had in the ground, or near it, so as to be had at a low price, I would use it, well tempered, and close rammed down, as a retainer for the sides and bottoms of all such of them as are placed or sunk in the ground. The receiving and filtering reservoirs

fervoirs may be formed of bricks, fet in fuch clay, at about fix inches thick from them; or, as before intimated, thefe may be formed wholly of wood, in the way the workmen of the city of London conftruct what they call backs, but will be expenfive. The bottoms and fides of the evaporating refervoirs may be covered with boards, and fecured at the ends and middle upon frames or joifts, ftretching the length of the refervoirs; or with fquare-edged bricks on flat or fquare tiles; or with bricks or tiles covered with, or fet in, tarras, or any fuch like good cement or mortar. In the fituation where it is firft defigned to apply his machinery and operations, near the city of London, to the evaporation of water from the foap-makers wafte or caft-off leys, there not being proper clay in the ground, or near at hand, and the ground lying rather low and difpofed to be damp, it is intended to form the evaporating refervoirs wholly of wooden boards, clofe jointed, fo as to retain the folutions; to reft them upon logs of wood, or other pillars, being fupported from pillar to pillar, by fufficient bearers, at about a foot from the ground; and to excavate and take away a part of the earth underneath them, fo as to leave room for a perfon to pafs occafionally through, and examine whether they be fo tight as not to admit of the folutions to exude through the joifts, or any accidental opening or crevice.

4 It

It is impossible to ascertain minutely now, by directions and description, the greater eligibility of one material rather than another, of which to construct these reservoirs; the choice depending so much on situation, the value of the solutions, and other circumstances observed on. The situation must be viewed, and proper estimates made of various articles, by which the judgement may be guided. It may however be remarked, that reservoirs constructed of wood, if not objectionable, as to cost, will be better for retaining alkaline solutions than those made of most other cheap materials; for alkaline compounds, in which there is an excess of alkaline salt, will take up into solution (and so may be said to corrode) siliceous and argillaceous earths, of which common clay is almost wholly composed, and also the siliceous or sandy part of the cements called mortars or tarras, in proportion to the excess of alkali, whether vegetable or mineral. Weak or mild alkaline solutions will be long in corroding, or taking into solution, clay, or the siliceous part of well prepared cements or mortars; but he would caution those who may follow him, or may use his invention, that an exudation or loss of the solution may take place, when they are not aware; for the idea that the water may alone exude, and the contained salts remain, is a mistaken one. Salts will pass, with their water of solution, even through glazed

glazed earthen-ware, as he has often experienced; like remarks may be made refpecting fome acid folutions. Refervoirs conftructed with bricks and common mortar, and well covered, or of wood covered, either wholly or only at the joints, with pitch, may be very proper and cheap, in fome cafes, for retaining fuch folutions as will not decompofe or corrode the pitch. And it may be obferved, that black, being the colouring material moft heated by the direction of the rays from the fun, (as appears by its abforption of them, and from experience,) may be applied, in fome inftances, to the evaporating refervoirs and machinery; fo that, by increafing the heat, the evaporation may be helped. I come now to,

V. *The Evaporating Machinery, to promote Evaporation, and protect the Solutions from Rain or Dews falling into or incorporating with them.* And firft, the wheel machinery, refembling the fly of a fmoak-jack, but placed vertically, and its covers. The ufe and dimenfions of this, as well as of every other contrivance intended to effect the purpofe, muft neceffarily be regulated by fituation, and the quantity defigned to be expofed to evaporation. Suppofe the evaporating refervoirs to be from about two to three hundred feet in length, extending from eaft to weft, and about fifteen feet in breadth, from north to fouth, which may be the moft proper dimenfions, in many fitu-

ations where the principles of the patent are adopted; then, over these reservoirs are to be placed roofs or frames, formed of thin boards or framed canvas, (or any other coarse cloth or stuff fit for the purpose,) from which the rain may run off, as from an umbrella, and not penetrate through, and mix with the solutions. These are to be affixed, by strong hinges, to poles or pieces of wood, extending from east to west, like the ridging of the roof of a house; and are to be supported by other posts, poles, or pieces of wood, placed perpendicular to the horizon: I will call them,

VI. *The moveable Roofs.* If the evaporating reservoirs are about fifteen feet broad, and the wheels or flies (which will hereafter be described) are about twelve feet diameter, these moveable roofs may be each about fifteen feet long; and, at the ends of the frames (or the pieces of wood to which the boards of the frames, or the frame-pieces formed of canvas or coarse cloth, or the like, are secured,) are to be fixed poles or staffs, by staples or hinges, so as to lift up the roofs to a few degrees above the horizontal level of the solutions below, and there support them; or to let them down, that they may form a covering to protect the solutions from rain or dew; for which they must be sufficient, and must be made tight, or be covered, at the joints where the

the hinges are, so as not to admit the rain to fall through at the ridges: below these moveable roofs or coverings, must be fixed,

VII. *Wheels or Flies*, with their axles resting towards the north and south, in proper bushes or supporters, rising from, and fastened to, the sides of the evaporating reservoirs. The diameter of the wheels will of course extend towards east and west; and, to the extremities of the parts composing the flies or wheels, are to be fixed thin boards, extending perpendicularly from the line of their circumference, towards north and south. To these must be affixed other pieces, both at the ends and going lineally with the circumference of the wheel, so as to form a kind of shovel, to take up and disperse the solutions. These fly-wheels are to be so constructed as to be set in motion by the wind, when blowing with a needful degree of strength, and in certain directions; and are to be so hung upon their supporters, that the shovels, as they move, may dip into the solutions, take up, and disperse them over the surfaces of the wheels, and the surfaces projecting from them, that they may be exposed to the effects of the sun and air, and the aqueous parts carried off in vapours, or evaporated. The supporters, in which are placed the bushes on which the axles of the wheels are to rest and move, must have at the top, frames or pieces of wood, extend-

ing from them at right angles, into each of which are to be inserted three or four bushes, that the axles of the wheels may be occasionally moved and shifted into them, so that the lines of their diameters (the wheels) may be placed from towards east and west, to towards north and south, or south and north; that they may be properly exposed to the direction of the wind, by which they may be kept in motion, and revolving upon the axles: the axles are to be fastened into the bushes by proper hasps. When the wind does not blow with sufficient force, or in a proper direction to give motion to the wheels, when loaded with the solutions adhering to them, and to the projecting materials designed to make an increase of the surfaces of such solutions, they must be moved by some other power. These fly-wheels must have various substances fixed to them, such as reeds, or branching twigs of trees, projecting from their surfaces; but they must not be so numerous, or so heavy, when loaded with the solutions taken up and dispersed, as materially to affect their being kept in motion by the wind; nor must they be obscured, but sufficiently and fully exposed to the effects of the sun and air.

VIII. Instead of, or in addition to, the above-mentioned fly-wheels, (designed to be operated upon and set in motion by the wind,) wheels may be placed in like manner, made of thin boards,

framed

framed cloth, &c. (of the full area and circumference of a circle,) the diameters of which must necessarily depend on circumstances, (before alluded to;) and these may be covered on both sides, especially towards the south, with various substances projecting out, and fixed to them, for the purpose of dividing and increasing the surfaces of the fluid; and must have shovels fixed to them, in the same manner as the fly-wheels. These wheels, as well as the former, must have, at the north end of each of the axles, a projection of a few inches; into which, cross staffs must be fixed, at right angles, that they may be turned round in succession, and the solutions taken up, and dispersed over the surfaces, to keep them wet and dripping; which must also be done to the fly-wheels, when they are not kept in motion by the wind. Various other mechanical powers may also be applied for this purpose, and so as to keep the wheels in continual motion.

IX. *The Evaporating Machinery, resembling a Drawbridge, or the Frame-Machinery.* This class of machinery may succeed the others, or not; situations and circumstances can alone determine. They may be constructed cheaper than those before described, of proportionable size; may be worked where the fly-wheels cannot, for want of a sufficient current of air, unless motion be given to them by some other power, and will, for many

reasons,

reafons, be generally preferable to the plain wheels, and to both, in refpect that the folutions may be more eafily covered and uncovered by them, as the moveable roofs will require more ftrength and labour to raife and let them fall, and of courfe more time, or more hands; hence it may be, in many inftances, beft to work with thefe alone. Whether they do or do not fucceed the operation of the former upon the contents of the evaporating refervoirs, they are to be conftructed thus. On the north fide of the evaporating refervoirs, pillars are to be fet up, and fixed in the ground, of fuch heights and fcantling as may be conformable to the breadth of the refervoirs, the extent of furface wanted, and the extent of the frames when loaded with the folutions. Suppofe thefe refervoirs to be from about two to about three hundred feet long, and about fifteen feet wide, as has been fuppofed before to be generally moft convenient; then he would have the pillars put down at about twelve or fifteen feet diftance from the centre of the perpendicular direction of each other, to be about feventeen or eighteen feet high, about nine inches broad, and of ftrength proportioned to the weight they are to fupport; they muft be funk in the ground, to fuch a fufficient depth that they may ftand firm, and have ftays, on the north fide, at the bottom. Thefe pillars being placed at about fix inches diftance from

from the evaporating reſervoirs, in the ſpace between them muſt be put down other pillars, of the breadth of the pillars, and ſo thick as exactly to fill up the ſpace, which are to be ſunk into the ground about ſix or nine inches deeper than the pillars. On the tops of each of theſe, on a level with the north edge or brim of the reſervoirs, (which muſt be a little lower than the ſouth edge, that the ſolutions, when the frames are dipped, may not be thrown over the latter,) are to be affixed, with buſhes and forelocked bolts, to iron eyes or loop-holes projecting by ſtrong iron ſtraps from the ſouth ſide of the pillars, two poſts or ſupporters to the frames, which I will call the *frame-ſupporters*; of ſuch length that they may exactly meet and fall into the oppoſite ſide of the reſervoirs, and ſo, reſting in part on thoſe logs, which I call *frame-logs*, and partly on the bolt like the pin of a hinge paſſing through them, they may be raiſed towards a perpendicular height, or let fall at pleaſure. To other frame-logs, or to other pillars to the right hand and left or eaſt and weſt of theſe are to be affixed like frame-ſupporters, and in the ſame manner. Thus, three pillars will comprize in their extent two ſets of this part of the machinery; to the lower edge of two of theſe frame-ſupporters are to be faſtened, from pillar to pillar, thin boards of wood, or frames of well-ſtretched canvas, or other cloth or ſtuff. If

boards be uſed, they muſt lap, or be fixed at the edges, one over another; ſo that, when the frames, which I will call *evaporating-frames*, are ſuſpended at an angle, ſuppoſe thirty degrees, they may form a roof or cover, from which the rain, as it deſcends, may run off, and alſo the ſolutions, as they are taken up upon them. On the ſouth or lower ſide, the boards may be ſtrengthened, and ſecured to each other, by battens running acroſs them. On the tops of the pillars are to be fixed, by ſtout hinges, with the pins of the hinges on the north ſide of the pillars, and ſtraps going round the tops of the pillars, two bars or pieces of wood, ſo as to conſtitute levers or balances; when theſe are ſuſpended horizontally, a cord or chain muſt drop from their ſouth ends vertically, and be ſecured to the frame-ſupporters. Theſe bars or pieces of wood, which I will call *evaporating-levers*, muſt be made tapering; ſo that, when they are ſuſpended in an horizontal direction, the ſouth end of the lever may be the ſmaller and lighter, and the north end the larger and heavier. If the evaporating reſervoirs be about fifteen feet wide, I would have the ſouth end of the evaporating levers from about twelve to fifteen feet long, and the north end about ſeventeen to eighteen feet long; where they muſt be joined by other pieces of wood, of ſuch weight that, with the aid of the ſtrength of a man, they may

may easily counterpoise the evaporating frames loaded with the solutions, and move them. The south sides of these evaporating frames are to have reeds, branching twigs of trees, or other light materials, fastened to them, but not to project so far as to prevent their dipping properly into the solutions: these will not produce an increase of surface by their number, but occasion a dripping after being immerged. When the solutions are very much concentrated, they may be removed, or else they must be afterwards washed with weaker solutions, or a part of the machinery may be wholly without them, for solutions in that state.

The Operations with the Frame-Machinery. The evaporating reservoirs, and this part of the machinery, being thus prepared, the reservoirs must be nearly filled with the solutions from the receiving or filtering reservoirs, and the frames let down and dipped into them by the levers, so that the extremity of the upper surface of the south end may be dipped or plunged from two to three inches; after which, the frames are to be raised up, and the levers fixed, by means of a cord, or other such contrivance, to the pillars, so as to support the frames standing towards a perpendicular direction, but inclining a few degrees to the south; both the north and the south sides of the frames, and the projecting surfaces from the latter,

latter, will thus be wetted, and exposed to the effects of the sun and air. At that which will be the lower end of the frames, when thus raised, must be left an opening through its whole breadth; so that, when the fluid is taken up upon the north side, as it runs down, it may pass through this opening into the reservoirs; and, that this space may be made the most of, as to the effect of evaporation, there are to be reeds, branching twigs of trees, or other things of that sort, suspended from the bottom of the frame above; yet not in such number, or so close to each other, as either to impede materially the passing of the fluid, or cause it to fly forward to the ground and be lost. When the wind blows with a great force, these reeds, &c. may be removed, that the solutions, as they are divided in passing through them, may not be blown away. The doing of this depends entirely on their value, and the degree and force of the wind; during fair weather, people must thus proceed, plunging, wetting, and raising these frames successively, till the evaporation be carried on to such a degree, that it is no longer prudent to attempt its continuance without the aid of fuel; when the solutions must be run off into reservoirs, to be put into iron pans, or run off directly into the pans, that the evaporation may be perfected in the usual way; and, if any salts have crystalized, and fallen to the

the bottom of the refervoirs, they muft be taken away, and treated as is cuftomary. As the evaporation will proceed quicker when the folutions are weak and contain much water, than when they are concentrated and contain but little, the evaporating refervoirs muft be divided into compartments, (the number depending on the length of the refervoirs,) by boards running acrofs them, to which the frame-machinery muft be fo adapted, where they are put, that the edges of the frame-fupporters may pafs the edges of thefe dividing boards, and dip, with the frames, into the contents of the refervoirs. The wheel or fly machinery muft alfo be adapted properly to thefe compartments. The bottoms of each of the compartments into which the folutions are firft put, muft be nearly on a level with the furfaces of the adjoining ones, into which, when the boards are lifted up, the folutions concentrated to a certain degree may pafs, and be treated in the like manner; then paffed or run into a third, and fo on, juft as circumftances, and their degree of ftrength, may point out. When rain or dew falls, the frames muft be let down, fo as to form roofs for the protection of the folutions, from which the water may run off; and the openings of the lower parts of the fufpended frames muft then be covered up by light frames, as long as the evaporating frames are broad, which may

be placed upon ſtays fixed to the frame-ſupporters, and enter, as into a groove, below the bottom of the principal frames, where they may be ſecured, and ſo receive and carry off the water. Or ſome ſolutions of little value may be covered up, by letting fall a flap, either of thin boards or framed canvas, jointed by canvas, or any other proper material, to the edges of the frames above. On the ſouth ſide, painted or payed canvas, or other coarſe cloth or proper ſtuff, muſt be raiſed and faſtened to that edge of the frames extending from the ſides of the reſervoirs, to protect the ſolutions on that ſide, when the frames form a roof to carry off the water. Before theſe frames for the openings are fixed, or the flaps let down, ſome of the rain ſhould be ſuffered to paſs over the ſurfaces of the frames, (which will reſemble a roof,) through the openings into the reſervoirs, to waſh into them ſuch part of the ſolutions as may be adhering, that they may not be carried on to the ground and be loſt, eſpecially if they be concentrated and valuable. In ſhowery weather, when rain is often expected, it will be proper to work only with the ſouth or lower ſide of the frames, and omit to dip the upper, keeping on the moveable frame, or the flap down, but the former a little ſhoved up into the grooves, that the ſolutions may be more effectually preſerved, particularly if they are ſtrong

ſtrong in ſalts. With the above general deſcriptions and directions, are included ſuch operations as more particularly belong to valuable ſolutions. I ſhall now obſerve upon ſome particulars, which may more eſpecially relate to the evaporation of water from the ſalt water of the ſea. The ſea water, being let into large open ponds or reſervoirs, as is done at Lymington, in the ſouth of England, and in France, that the earthly impurities may ſubſide to the bottom, and ſuch part of the water be evaporated in theſe open ponds, as the ſtate of the weather and other circumſtances may conveniently admit, muſt afterwards be paſſed into evaporating reſervoirs, to which theſe principles, machinery, and operations, may be applied. The evaporating reſervoirs for this purpoſe are to be conſtructed in much the ſame way as thoſe before deſcribed; but it is not requiſite that ſo much care and expence ſhould be employed to make the firſt ranges of them tight, for retaining the ſolutions while they are yet weak and but little concentrated, becauſe of the ſmall value of ſea water, compared with ſuch ſolutions as the ſoap-makers waſte leys, or others for which a conſiderable price is or may be paid. Theſe firſt ranges of reſervoirs and machinery, deſigned for the reception of the ſea water, which has (or has not) undergone a certain degree of concentration in the

open

open ponds, may be formed of clay only, or any other cheap material, which will pretty well retain the fluid. But, in this case, they must either be of such sufficient depth, that the dipping of the evaporating frames, or moving of the wheels, may not cause the close rammed prepared clay or mud made use of to be mingled with the solutions, (sea water, or salt brine,) so as to make them muddy, or else, after passing these, they must be run off into other large and deep reservoirs, that the earthy particles may subside, and the brine or solutions be cleared; and filtration, as has been before described, may sometimes be employed to advantage for this purpose. The succeeding reservoirs, especially those in which the salt is designed to be formed, (by the crystalization which will take place on the evaporation of the water,) must be made with much the same care as those described before, in IV, and the fluid passed in the same manner from one to another; as the concentration advances, constant attention must be paid to skim off the impurities which may arise upon the surface, as before directed. In summer, and when the seasons permit, as much salt will of course be suffered to form or crystalize, and be taken up (or, as is termed, drawn) as is possible. When salt is not formed or crystalized, in the evaporating reservoirs, by the operation of the sun and air, the salt

salt brine solutions are to be brought as near as prudence will admit to the point of saturation, and are then to be run off into reservoirs, where they may be kept, to be farther purified by the subsiding or precipitation of the earthy impurities, and afterwards put into iron pans, (or directly run off into the pans,) to be boiled down to salt in the usual way; and the salt brine which may remain in the reservoirs, after salt has been formed and drawn, is to be treated in the same manner. But it may be observed, that if the boiling or evaporation of water from the salt, by the aid of fuel, be conducted slowly or moderately, the salt will crystalize in larger grains, and be more perfect for the preservation of animal substances than when they are small, and produced by quick boiling to promote evaporation.

Observations. Wooden boards, for the evaporating frames and moveable roofs, may be preferred to canvas or other cloth, for all those solutions which would tend to destroy the cloth, as all which contain an excess of alkaline salt certainly would. If canvas, or any sort of cloth, be used for such solutions, it ought to be well painted or payed, which would be expensive, and even that would secure it but imperfectly from their effects. This objection to framed cloth or canvas does not extend to the salt water of the sea; for,

for, as evaporating frames or protecting covers constructed with such materials would be much lighter than if of wooden boards, they may be more eligible, as they would require less power and strength to work and apply them. For evaporating water from the salt water of the sea, open cheap canvas, or such like cloth, or hair cloth, stretched and fixed to wooden frames, made no heavier than is necessary, may be the best, both for the moveable roofs and evaporating frames; and the reeds, branching twigs, &c. may be attached to the wooden frames of the latter. These may very well be worked by single levers, fixed in the manner of the double ones, but to pillars standing to face the middle of each frame, at the distance of a few inches from the reservoirs; and the frames, in this case, are to be hinged upon the frame logs, in the way before described, but with eyes or loop holes projecting by iron straps from the frame logs themselves. These frames may also be hinged in many other ways. The evaporating frames, of whatever material they be made, may be taken up and let down by single levers, or by cords and pullies fixed to posts, high suspended rails, &c. but he apprehends not with so much dispatch and steadiness as by the double levers described in IX, particularly if they be wholly of wood, and consequently heavy. In a valuable treatise upon salt, the late Doctor

 Brownrigg

Brownrigg has suggested some principles and modes for promoting evaporation from the salt water of the sea, or any salt brine, which have some conformity with a part of the patentee's machinery and operations. He has therefore solicited for an exclusive right to the use of new and improved machinery and operations, though he cannot learn that the ideas of Doctor Brownrigg have ever been brought to use. He is informed, indeed, that such machinery and operations as the Doctor has pointed out, have been made trial of, for evaporating water from sea water, but without success, as might be expected, when the expence is compared with the want of efficacy of his plan; and he takes notice of this, merely that no person may attempt the invasion of his patent, under pretext that it is only an improvement. He trusts and believes, that on the whole, his machinery and operations may be pronounced to be essentially new, (and he hopes useful,) at least in relation to their object; but he has his Majesty's letters of licence for new and improved machinery and operations, which he has endeavoured to describe and make discovery of, as truly, fully, and openly, as he has had ability to do. In witness whereof, &c.

XXIX. *Specification of the Patent granted to Mr.* WILLIAM JONES, *of the City of Briftol, Mill-wright and Engineer; for a Machine for the Purpofe of mixing more readily and intimately Malt, or other Subftances, with Fluids; whereby the Effence of the Malt, or other Subftances intended to be acted on by Water, or other Fluids, will be more perfectly and expeditioufly extracted than by any other Method hitherto invented.*

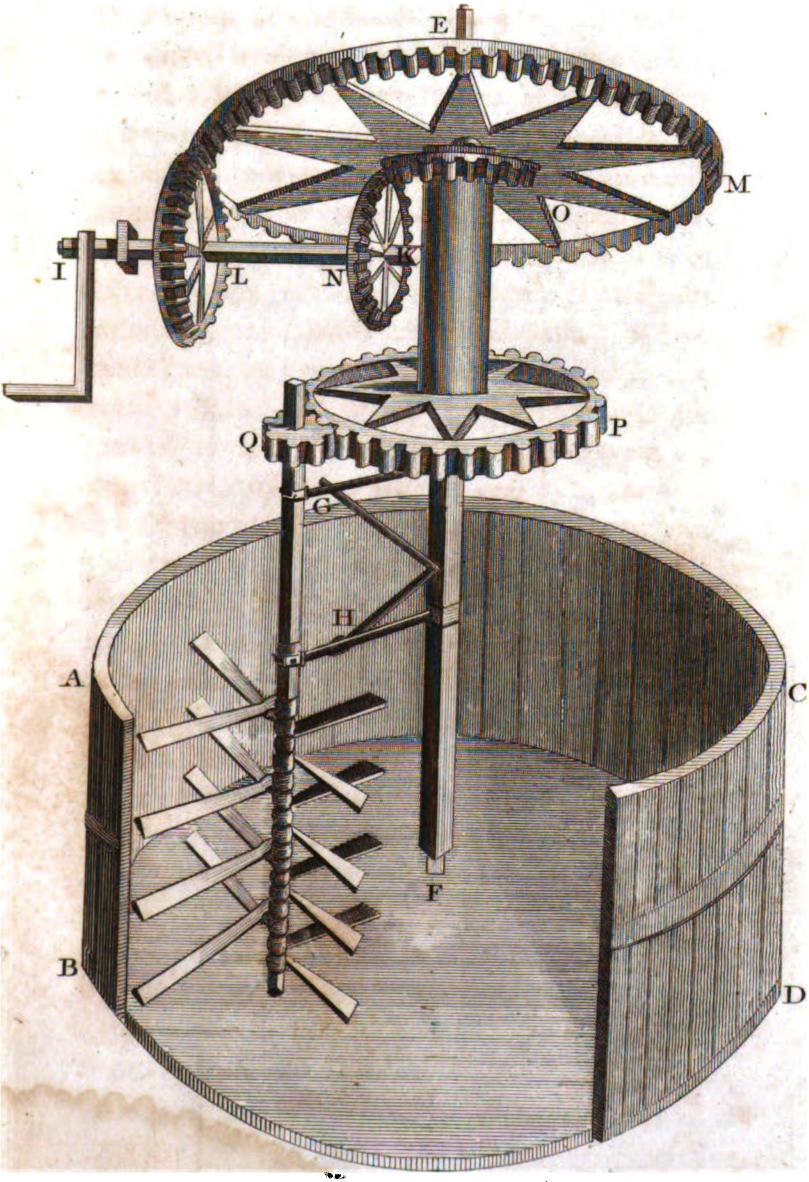
WITH A PLATE.

Dated May 8, 1798.

TO all to whom thefe prefents fhall come, &c. NOW KNOW YE, that in compliance with the faid provifo, I the faid William Jones do hereby defcribe and afcertain the nature and principle of my invention, as follows; that is to fay, my invention confifts in fuch a conftruction of machinery, to be fixed to, in, or about any mixing or mafhing vat or tub, as, on being put in motion, by the application of any power to be derived from water, wind, fteam, animals, or otherwife, fhall occafion the malt, meal, water, or other ingredients in the tub or vat, to mix intimately

timately together, and so to change their relative situations, as to cause the essence of the malt, meal, or other substances intended to be acted on by water, or other fluids, to be more perfectly and expeditiously extracted than by any other method hitherto invented; which machinery is delineated and described in the annexed figure; that is to say, A B C D (Plate X.) represents a section of a tub or vat, in which the operation is to be performed; to, in, about, or over which, such frame-work is to be fixed, as shall be sufficient to support and secure the several spindles, wheels, and other machinery hereinafter described; that is to say, E F, is an upright spindle, of iron, wood, or other materials, to which is strongly secured a frame G H, and also the bevel wheel M; which spindle rests and turns on a centre-socket, in the bottom of the vat or tub, at F, and in a collar at E. I K, is a horizontal spindle, turning in collars secured to the frame-work, on which are fixed the bevel-wheels L and N; on the rotation of which horizontal spindle, the wheel L communicates motion to the wheel M, together with the upright spindle to which it is fixed; whilst the wheel N puts in motion the wheels O and P, which are fixed together upon a hollow box or spindle, which is fitted to, and turns upon, a round part of the upright spindle E F. At the same time, the wheel P turns the wheel Q, which

is fixed on a ſpindle turning in a frame GH; and which laſt-mentioned ſpindle is continued down into the tub or vat, (into which the materials to be maſhed are put,) having, at certain diſtances, vanes of iron, or other ſubſtances, fixed round it, at ſuch angles with each other, and ſuch inclination or dip, that when the laſt-mentioned ſpindle revolves, the ſaid vanes or knives ſhall take in the whole, or nearly the whole, of the ſpace within their ſweep or extent. And, as the whole of the ſaid frame of vanes or knives is carried round the tub or vat, in the time in which a certain number of its own revolutions are accompliſhed, the whole of the materials to be maſhed or mixed are in turn divided and blended together; and, by the inclination of the vanes or knives, are raiſed from the bottom to the top, in one part of the tub or vat, whilſt a contrary motion takes place, in another part of the tub or vat. In which kind of planetary motion in the ſaid machine, I hereby declare the excellence of my ſaid invention principally to conſiſt, by whatever machinery it may be accompliſhed. In witneſs whereof, &c.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XXX. *Specification of the Patent granted to Mr.* Isaac Wheildon, *of Copthall-court, Throgmorton-ſtreet, London, Packer, and Mr.* John Bowler, *of Bear-lane, near Blackfriars-Bridge, in the County of Surrey, Machine-maker and Engineer; for their Method of making and working Preſſes, of all Kinds and Dimenſions, and particularly Packing-Preſſes and Hot-preſſes; by which Goods are packed and preſſed with much leſs Labour and Expence than by the common Preſſes now in Uſe, and conſiderably cloſer, and more even; and the various Sorts of Goods are, by this Invention, very much improved.*

WITH A PLATE.

Dated April 26, 1796.

TO all to whom theſe preſents ſhall come, &c. Now know ye, that in compliance with the ſaid proviſo, we the ſaid Iſaac Wheildon and John Bowler do hereby declare, that our ſaid invention, and the means of performing and putting the ſame in uſe, is deſcribed in manner following; that is to ſay, the principle on which our invention is founded, is the applying of chain, cog, or any other kind of wheel or wheels, of various

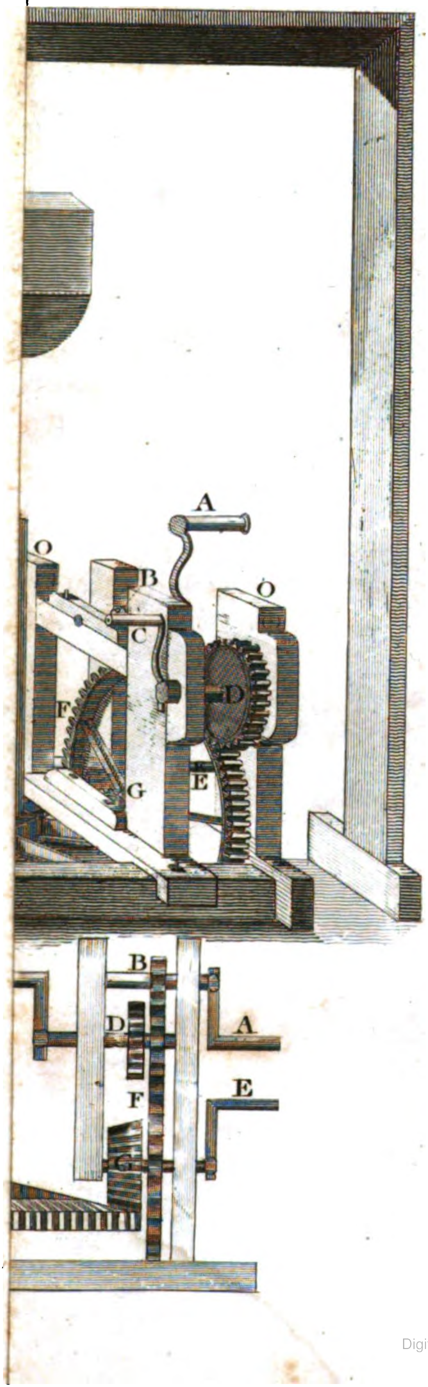
various forms and ſizes, and placed in various ſituations, (to be worked by a handle or handles,) which may be affixed or annexed to any kind of preſs or preſſes, for the purpoſe of power in preſſure, which has the advantage of compreſſing any ſubſtance capable of preſſure into leſs compaſs, with leſs labour, than the preſſes now in uſe. In purſuance of the ſaid letters patent to us granted, we do hereby aſcertain and deſcribe our ſaid invention, for which ſuch letters patent to us were granted; premiſing, and particularly meaning, that the ſize, dimenſions, and powers of our ſaid preſſes, may be ſo varied and applied to the various purpoſes to which they are applicable, as to prevent the ſpecifying any particular ſort or ſize. Their component parts may be made of wood, iron, braſs, or any other ſubſtance or ſubſtances capable of being brought to the ſhape and uſes hereafter deſcribed; and, in order that ſuch deſcription of our ſaid invention may be the more eaſily explained and comprehended, we have drawn, in the margin of theſe preſents, a preſs, according to our ſaid invention, which may be uſed for packing and preſſing bale, or any ſort of goods of great bulk, capable of preſſure; and, by varying the dimenſions of the component parts of the preſs here deſcribed, the invention may be applied, with equal advantage, to a preſs or preſſes of any other ſize than that here deſcribed.

Fig.

Fig. 1. (Plate XI.) represents a perspective view of a packing-press, according to our said invention. A, is a handle, that by turning gives motion to the machinery, by its turning the pinion B. C, is another handle, for a quicker motion, which is annexed to the axis of the larger pinion D; and E is another handle, which is occasionally fixed to the axis of the spur-wheel F, to be worked by a man standing in a hole beneath it; and, on the same axis, is a pinion G, which acts in a tooth and cog wheel H, and which is fixed to the bottom of the screw I. K, is a chain, which is connected with the cogs of the wheel H, and to the cogs of the wheel L, which turns the other screw M, (which screws rest on pivots,) and which causes the nut N to come down exactly level upon the substance to be pressed or packed, with an astonishing power of pressure; and, by turning the handle or handles the contrary way, it causes the nut N to rise to its proper station. O O, is a frame, with the multiplying wheels fixed therein, which is annexed to an end of the press; or it may be carried to its side, if necessary; and it may be inclosed with a covering or case, to keep it from dirt or injury. P P, is a frame for a platform or case to be fitted to, or upon it, which covers the whole of the bottom machinery.

Fig. 2. reprefents a front-view of the machinery, (with the fcrews broken off,) and a cog-wheel applied to the centre, to work inftead of the chain, as before fpecified. A, is a handle, that by turning gives motion to the pinion B. C, is another handle, which is ufed for a quicker motion, and is connected with the axis of the pinion D, and is made to fhove in and out of the teeth of the fpur-wheel F. E, is another handle, to be occafionally fixed to the axis of the fpur-wheel F, to be worked as before defcribed; and, on the fame axis, is a bevel-pinion G, which acts in a bevel-face wheel H, which is likewife cogged round its edge, and is affixed to the bottom of the fcrew I, which gives motion to the centre cog-wheel K, which gives motion to the other cog-wheel L, which is affixed to the bottom of the other fcrew M, which caufes the nut to defcend with the fame preffure as above fet forth and defcribed. In witnefs whereof, &c.

XXXI.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XXXI. *Remarks on a common Error reſpecting the Expanſion of Water, when converted into Steam. In a Letter to the Editors.*

GENTLEMEN,

A MOST flagrant error having been propagated and publiſhed, volume after volume, and year after year, for upwards of fifty years paſt, I beg you will, through the conveyance of the Repertory of Arts, &c. preſent the public with the following account of its origin and detection.

It has been generally received among thoſe who read, and rely on the veracity and experience of their author, that water, when expanded by heat to that degree of elaſticity common to a ſteam-engine, occupies 13000 times its original ſpace; and the author generally quoted on this occaſion, is the celebrated Doctor Deſaguliers.

I have been much ſurpriſed, that the fact ſhould remain ſo long uncontroverted; but moſt of all to find that men of ſcience, who though they would not receive it from verbal report, have notwithſtanding read the paſſage in the doctor's lectures, where the error, (as conſpicuous as the paper on which it is printed,) in the ſecond vo-

lume, page 533, ſtands thus, in connection with Mr. Beighton's experiment.

" *Mr. Beighton's Account of an Experiment which*
" *he made on the Fire-Engine, to know what*
" *Quantity of Steam a cubical Inch of Water pro-*
" *duces.*

" I found by ſeveral experiments, by a divided " ſteelyard on the puppet or ſafety valve, on the " top of the boilers at Griff and Waſington, " that when the elaſticity of ſteam was juſt " one pound avoirdupois on a ſquare inch, it " was ſufficient to work the engine; and that " about five pints in a minute would feed the " boiler, as faſt as it conſumed in boiling and " ſteam for the cylinder ſixteen ſtrokes in a mi- " nute. Griff cylinder held 113 gallons of " ſteam, every ſtroke × by 16 ſtrokes in a mi- " nute = 1808 ale gallons; ſo five pints of water " produced 1808 gallons of ſteam, 38.2 cubic " inches in one pint. Then, 38.2 inches : 1808 " gallons : : 1 inch : 47 gallons and three tenths; " hence it appears, one cubic inch of water, by " boiling till its elaſticity is capable of over- " coming about one-fifteenth of the atmoſphere, " will make 13 thouſand 338 cubic inches of " ſteam."

Now obſerve, he eſtimates the gallons of ſteam paſſing into the cylinder in one minute at 1808, and

and says that this 1808 gallons of steam is the produce of 5 pints of water, 38.2 cubic inches to the pint. But, when he comes to state the terms, for the purpose of shewing the expansion of one inch of water, he makes his first term to be the inches in *one pint*, instead of the inches in *five pints*; and, according to him, it stands thus, as 38.2 : 1808 :: 1 : 47.3; whereas it should be exactly as follows, as 191 : 1808 :: 1 : 9.4+. Now this could not be a typographical error, the terms all agreeing with one another, and the true statement of it makes nine gallons instead of forty-seven, and 9.4 × 282 = 2650.8, and 13338 — 2650.8 = 10687.2; consequently, the difference is *only* upwards of ten thousand out of thirteen, according to the experiment: but even the experiment itself *must not* be admitted as fair and decisive, seeing the cylinder was cooled by the condensing water at every stroke of the engine, by which much of the steam from the boiler must have been in a state of condensation while it entered the cylinder; so that Mr. Beighton's experiment, and the Doctor's account of it, ought to go for nothing. I am, &c.

J. C. H.

Pittman's Buildings, City Road,
May 21, 1798.

N. B. These lectures have been translated into other languages, with the same erroneous statement.

 XXXII.

XXXII. *Description of an easy Method of clearing Wells, &c. of noxious Air. In a Letter to the Editors, from Mr.* T. E. SALMON, *of Canterbury.*

WITH A PLATE.

THE ufual mode of clearing wells of noxious air, by means of forge-bellows and a leather pipe, is certainly very efficacious; but fuch bellows, &c. are feldom to be procured on the fpot, when wanted, and are too weighty and cumberfome to carry about. The following apparatus (invented by me) I have ufed with great fuccefs; and as, with fifty feet of pipe, it weighs only thirty pounds, it may eafily be carried to any diftance.

Tubes of every kind, being perpendicularly fituated, and having their internal air rarified, caufe a current or ftream of air to afcend through them. A, B, C, D, E, F, (Plate XII. Fig. 1.) reprefent fix lengths of metal pipe, each eight feet long and two inches diameter; they are all made of tin plate, except the upper one F, which is of copper, the better to bear the heat. G, is a veffel, alfo made of tin, holding about two gallons, fixed faft to the upper pipe F; and having through the fides of it a number of holes, to

admit

admit air for the ſupport of the fire. The veſſel muſt be ſo fixed as to have at leaſt five feet of pipe above its top.

The method of placing it in the well is, by firſt taking the bottom length A, into the upper end of which enters the lower end of B, and paſſing a wire through both, (to prevent their drawing apart again,) as at *a*, *a*, in holes made for that purpoſe: then fill the joint round with oil-putty, ſo as to render it air-tight. The upper end of each length is wired, to prevent bending; which wiring alſo forms a receptacle for the putty. Then proceed in the ſame manner with the remainder of the pipes, until the bottom one nearly reaches the ſurface of the water, but not quite. The veſſel G is to be ſupported on two timbers, placed, for that purpoſe, acroſs the top of the well. H, is a conical cover, to prevent the heat from paſſing away too rapidly, and to confine it to the ſides of the pipe.

The apparatus being thus fixed, it ſoon becomes filled with air of the ſame quality as that in the well; and, as their power of gravity is the ſame, both the external and internal air become ſtationary, from which there can be no good effect. To put the experiment into execution, fill the kettle G with lighted charcoal, or wood, &c. the copper pipe F being by this means heated, a rarefaction of the internal air takes place, which air, by this means, is deprived of its gravity, and the

the external denſe air continuing to preſs with the ſame weight as at firſt into the bottom end of the tube, the equilibrium is deſtroyed, and a ſucceſſion of noxious air paſſes up through the pipe, as through the funnel of a chimney, till the whole quantity is carried off; after which, the pure air, which has in the mean time introduced inſelf into the well, begins to paſs off by the ſame paſſage, ſo long as the fire is continued.

It may not be amiſs here to obſerve, that although the ſtream of air paſſing out of the top of F ſeems *ſmall*, yet the effect is *great*, becauſe that ſtream conſiſts intirely of the noxious air that is required to be removed; whereas, by the uſual method of large bellows and leather pipe, ten gallons of freſh air is perhaps blown into the well, before two gallons of noxious air is diſplaced; and this probably happens becauſe the atmoſpheric air is ſpecifically lighter than the noxious air, and aſcends through the latter to the top of the well, diſplacing but a ſmall proportion of it.

The effect ſeems greater, when the fire-kettle G is placed lower on the pipe, as at D, as by that means more internal air becomes rarified; but it is attended with this diſadvantage, that the charcoal-fire renders the air in the well unfit for reſpiration. I am, &c. T. E. SALMON.

XXXIII. *Conclusion of Mr.* Collier's *Experiments and Observations on Fermentation, and the Distillation of Ardent Spirit.*

(From Page 192.)

II. I SHALL now proceed to the second enquiry. Is a greater quantity of spirit obtained by a free admission, or a total exclusion, of the atmospherical air?

Boerhaave mentions a free admission and emission of the common air, as one of the things necessary to promote fermentation, and his opinion has prevailed to the present day; for M. Chaptal observes, that in order to develop this fermentation, there is required, first, the access of air. Now, if these assertions were true, my account of the operation of fermentation would be essentially wrong; but the following facts will prove, that so far from a free access of common air being necessary to the spirituous fermentation, it is highly injurious.

I took a bushel of malt, and infused it in a sufficient quantity of water, of 180° of heat, for an hour, and then drew off six gallons.

With

With water of 200° of heat, I again infufed the fame malt another hour, and drew off an equal quantity.

With water of 212° of heat, infufed for an hour longer, I drew off fix gallons more.

When the liquor was reduced to fixty degrees of heat, the gravity of each, by my hydrometer, was as follows.

The firft infufion had fifty-four degrees of denfity, the fecond forty-five, and the third twenty-five.

The fix gallons of each infufion were divided into two equal parts; the one for clofe, the other for open fermentation. Thefe were pitched, with four ounces of yeft refpectively, the firft two parcels at 66° of heat, the fecond at 60°, and the third at 55°.

The reafon of operating on liquors of different denfities, and pitching them at different degrees of heat, will be explained hereafter. They are now to be confidered as fix different experiments, in fupport of one fact.

The veffels ufed for the open fermentation were jars, equally wide at the top as at the bottom, or rather wider. Of thofe for clofe fermentation, I have given two drawings (fee Plate XII. Figs. 2 and 3.) I prefer having the ends of the tubes immerfed in water, as I think it anfwers the purpofe better than common valves. If the veffel be clofed

closed round the tube, it is equally air-tight, and the resistance of the water will not be too great for the elasticity of the carbonic acid gas, and other fluids which are raised during the intestine motion; nor is there any fear of the elasticity of the air in the vessel being overcome, by the pressure of the atmospherical air on the surface of the water.

The fermentation was continued till all signs of fermentation had subsided; the contents of each vessel were then carefully distilled, and their products were as follows.

Table of the Quantity and Strength of the Spirit obtained by the foregoing Processes.

Gallons of wort.	Density in each experiment.	Heat at which the yest was added.	Ounces of spirit produced.	Degrees below proof.	
				In the closed vessel.	In the open vessel
I. Six gallons divided into two equal parts.					
3	54	66	96	56	74
II. Six gallons divided into two equal parts.					
3	45	60	96	65	83
III. Six gallons divided into two equal parts.					
3	25	55	96	93	103

N. B. The gravity of the spirit was ascertained by Dicas's hydrometer, and the density of the worts by my own saccharometer.

 I have

I have frequently repeated the above experiments, varying the denfity and heat of the liquors, as well as the quantity and quality of the ferments; and the fpirit produced was always equally in favour of clofe, in preference to open fermentation. This was alfo the cafe, whatever modification of fermentable matter I ufed, whether molaffes, fugar, or potatoes.

I may here obferve, on the fubject of potatoes, that they never anfwered the expectation which I had formed from the account given by Dr. Anderfon. To procure five quarts of fpirit, from feventy pounds of potatoes, appeared very extraordinary; but, from repeated experiments, I am thoroughly fatisfied, that it is not poffible, either by the plan propofed by Dr. Anderfon, or by any other with which we are acquainted. The farina obtained from feventy pounds of potatoes does not exceed fourteen pounds, (a fact which I have proved by carefully collecting it;) and good molaffes, by a well regulated fermentation, will not form more than its bulk of fpirit; from which it will appear very improbable, that ten pints of fpirit can be produced from the above quantity of farina *.

* This fact fhews us how erroneous the common opinion is, of mixing potatoes with bread, as an object of œconomy.

In

In the courſe of theſe experiments, I was aſtoniſhed to find ſo great a diſproportion in the quantity of my liquors, after fermentation. On reflection, it would readily occur, that there would be a diminution of bulk, in that which was fermented in the open veſſel; but it was ſo great, that I at firſt ſuſpected an error had been committed in dividing the liquors; however, from repeated obſervation, the difference was ſo evident, that I made the two following experiments more accurately, to determine the fact.

I took eleven quarts, three ounces and a half, of wort, to which I added four ounces of yeſt, and fermented it in the cloſe veſſel for twelve days; at the end of which time it had loſt eight ounces by meaſure.

An equal quantity of wort and yeſt was fermented in an open veſſel, for the ſame length of time, and exactly in the ſame temperature. On meaſuring this ſecond quantity, I found a diminution of forty ounces.

To determine with certainty whether the liquors remaining in each veſſel were equally good, I ſeparately diſtilled the two, leaving out thirty-two ounces of the latter, (which was the difference in quantity,) and the ſpirit produced from each was exactly alike.

From the two foregoing facts, our information is ſtill more complete; as we not only obſerve the

great faving in the liquor by clofe fermentation, but we alfo fee that a diminution of eight ounces had taken place in the clofe veffel; and we have good grounds for fuppofing, that it is an actual diminution of the whole of the fermenting mafs; from the confideration of which, we fhall not be furprifed that Chaptal made vinegar from the fluids thrown off by fermentation *.

This part of the fubject appeared too interefting to be left without a little farther inveftigation; as fome chemical writers of eminence have ftated, that it was pure unadulterated carbonic acid gas which was thrown off by fermentation; others, that it was carbonic acid gas combined with pure alcohol; while many have fuppofed it to be an union of gas, alcohol, and water †; but none,

* M. I. A. Chaptal communicated to the Academy at Paris (1796) an obfervation of fome curiofity refpecting the formation of vinegar. He placed fome diftilled water above the vinous fluid in fermentation, to impregnate it with carbonic acid. The water, thus impregnated, afforded vinegar; and, at the end of fome months, a depofition was made, of a fubftance in flocks, which was analogous to the fibrous matter of vegetables.

† Lavoifier fays, "when this gas is carefully gathered, it is found to be carbonic acid, perfectly pure, and free from admixture with any other fpecies of air or gas." But his tranflator obferves, "that the perfect purity muft be taken with fome allowance; for it almoft always (I believe conftantly) contains fome alcohol, befides a confiderable quantity of aqueous gas, or water, in folution. The latter does not affect its purity, the former does, in fome degree."

whofe

whose opinion I have seen, have stated it to be what it is, *viz.* all the elementary principles of the fermenting liquor, highly surcharged with carbonic acid gas.

To determine this more fully, I made the following experiments.

To a fermenting tun, holding about ninety gallons of liquor, I connected two casks with bent tubes, in the manner of Woulfe's apparatus. The first cask was sufficiently large to hold all the yest and liquor which ran over the top of the tun, and was left empty to receive them. The second held a quantity of pure water, into which one end of the connecting tube was immersed. The apparatus was adjusted about six hours after the liquor had begun to ferment; and the water was subjected to the action of the fluids which came over in a gaseous state, for sixty hours.

The liquor was divided into three parts, the first of which was immediately distilled, and yielded a small quantity of spirit.

To the second I added, at a proper temperature, a little yest, and a new fermentation was excited; by means of which, the quantity of spirit produced was nearly double.

The third was placed in a proper degree of heat to make vinegar, and it is already acidulous.

III. *The*

III. *The Effects of different factitious Airs on fermenting Liquors.*

It has been before obſerved, that nothing but ſaccharine matter can be fermented; and the indefatigable Lavoiſier has proved, "that ſugar is a true vegetable oxide, with two baſes, compoſed of hydrogen and carbon, brought to the ſtate of an oxide by means of a certain portion of oxygen. Fermentation is the mere ſeparation of its elements into two portions; in which, one part is oxygenated at the expence of the other, ſo as to form carbonic acid; whilſt the other part is diſoxygenated in favour of the former, and is converted into the combuſtible ſubſtance called alcohol."

It was from a conſideration of theſe circumſtances, that I was induced to try what effect an atmoſphere of ſome factitious airs would have on fermentation.

My experiments on this part of the ſubject have been confined to hydrogen, oxygen, and a mixture of the two. The hydrogen gas was made by decompoſing water on iron-filings by heat, not by the ſulphuric acid; and the oxygen gas was obtained from the oxide of manganeſe. The proceſſes were conducted in the following

3 manner:

manner: I took three bottles, similar to that represented in Plate XII. Fig. 2, into each of which were put thirteen quarts of wort, of forty-five degrees of density; and to each bottle were added four ounces of yest. After the fermentation had begun, I fixed a bag, containing one of the gases, in the stopper of each vessel, by means of a stop-cock and screw. The respective gases were occasionally forced into the bottles, and mixed with the elastic fluids already produced. These operations were continued for eight days, and the bags were replenished with fresh gas every twenty-four hours.

The particular phænomena attending the fermentation of the liquor in each vessel were in no respect important, excepting that the flowers on the surface were not equal to what might have been expected, if no gas had been forced in; that into which the hydrogen gas was thrown was much inferior to the other two.

From observation I was, at first, scarcely able to determine, whether that supplied with a mixture of one part of oxygen and two of hydrogen, or that which was supplied with pure oxygen gas, had the better head; but, from close and repeated inspection, it appeared in favour of the latter.

On

On diſtillation, the ſpirit produced from each was as follows.

By pure oxygen gas . . .	30 oz.	110°	Below proof.
By pure hydrogen gas . . .	30	111°	
By a mixture of oxygen and hydrogen gas . . .	30	106°	

Moſt that we have learned from the three laſt experiments is, that they are none of them worth repeating as objects of profit; but they ſerve to confirm our opinion againſt the admiſſion of air to fermenting liquors. It is true, that none of the above gaſes were ſimilar to atmoſpherical air, as that is a mixture of oxygen, azote, and a little carbon *. I did not think it neceſſary to make any experiments with a mixture of oxygen and azote; for, as there is a column of air conſtantly riſing from fermenting ſubſtances, the weight of which is much greater than that of atmoſpherical air, we cannot ſuppoſe that the latter is ever freely admitted, or even admitted at all, in any of the common proceſſes of fermentation.

* One hundred parts of atmoſpherical air uſually conſiſt of twenty-ſeven parts of oxygen, and ſeventy-three of azotic gas; but the pure air is diminiſhed, and carbonic acid formed, according to the number of perſons breathing, or the quantity or quality of fuel burning, in an atmoſphere formed as above.

My

My observations on malting, mashing, fermenting, distilling, and rectifying, will be as brief as the nature of the different processes will admit.

Malting, which consists in developing the saccharine matter by germination, has been denominated, by some, the saccharine fermentation; but I see no more propriety in the term, than if it were adopted to express that progress in vegetation which changes mucilage into fœcula.

Margraaf extracted sugar from most vegetables, but it is more completely formed in some plants than in others, such as the *Arundo saccharifera*, and the *Acer saccharinum*. Manna is obtained from the leaves of fir, oak, juniper, and the maple-tree. The ash, which is very plenteous in Calabria and Sicily, affords that which is commonly sold both in flakes and in tears: it affords, by distillation, the same products as sugar. The analogy between saccharine matter, mucilages, and gums, is deducible from their containing the radical principle, which, in combination with oxygen, constitutes the oxalic acid: and *amylaceous fæcula* is only a slight alteration of mucilage, which may be converted into saccharine matter by germination. Saccharine matter must, therefore, be considered as one of

the immediate principles of vegetables, formed by the natural progress of vegetation.

In order to prepare barley for germination, it must be fully saturated with water, which generally requires it to be completely covered for sixty hours. After it is fully saturated, it must be removed; not only for fear of injuring the texture of the grain, but to prevent the water from robbing the barley of its most valuable quality; an occurrence which, in some degree, takes place by an ordinary and proper steeping. This is a fact not generally understood; however, it may be easily proved, by subjecting the cold infusion of barley to fermentation, whereby it will produce beer, from which, alcohol may be distilled.

When the barley is taken out of the water, it must be laid in a heap for twenty-four hours: if it were immediately spread thin, it would become dry; no heat would be generated, nor would any vegetation ensue. The grain must be afterwards spread on a cool floor, (if rather moist it would be better,) sprinkled with water, and turned two or three times a day, to give the whole an equal temperature, and keep it sufficiently moist. The appearance of the *aqua-spire* at the end of the corns, is the usual criterion for taking the malt to the kiln; but I should advise its being urged a little farther, that is to say, I would have the *aqua-spire* longer, before the grain is removed from the floor.

In

In drying, or what is generally called curing, malt, the heat ſhould only be continued until all the moiſture is diſſipated; for the ſpirit evaporates during the whole proceſs. This fact may be aſcertained by drying malt in a retort, to which a receiver is luted containing water; for the water will be found impregnated with ſpirit, in proportion to the malt dried, and the degree of heat which has been employed.

The method lately adopted, of cruſhing malt between metal rollers, is certainly preferable to the common proceſs of grinding.

Soft water ought to be invariably uſed for *maſhing*; and the heat ſhould, in ſome degree, be varied, according to the different qualities of the malt. But I ſhall ſuppoſe the malt to be good, and then lay down rules for extracting the ſaccharine matter.

If the water be of too great a degree of heat at the firſt maſhing, it will have a tendency to coagulate the malt, or unite the whole into a paſty maſs. On the contrary, if the heat be too low, the liquor will not become tranſparent, until ſome degree of acidity takes place. I would, therefore, recommend the following method, as the beſt calculated to preſerve tranſparency, and to obtain all the fermentable matter.

Infuſe the malt in a ſufficient quantity of water, of 160° of heat, for an hour; then draw

 off

off the wort, which will be found very ſmooth, ſoft, and ſweet.

With water of 180° of heat, infuſe the ſame malt another hour, and draw off the liquor as before. Some ſweetneſs will ſtill remain in the malt, for the obtaining of which, it muſt be again infuſed in boiling water for another hour. When theſe three infuſions are mixed and reduced to a proper heat, the artificial ferment (yeſt) may be added.

I have devoted ſo much of the firſt part of this eſſay to the ſubjects of *fermentation*, and the application of the ſaccharometer, that it is not neceſſary to enter at large upon them here. The great objects are, to regulate the heat according to the denſity of the liquor, before the yeſt is added; to keep the fermenting maſs in a proper temperature; and to pay ſtrict attention to the conſtruction of the veſſels; all of which may be deduced from the former experiments. The cloſe veſſels, to which tubes are adjuſted and immerſed in water, have ſome additional advantages, beſides thoſe already enumerated: they prevent, in ſome degree, the temperature of the ſurrounding atmoſphere from affecting the fermentation; and moſt effectually prevent any acidity from taking place, however long the operation is continued.

It

It is of considerable importance to have the liquor clear, and freed from all heterogeneous matter; and, if this has not been done by previous management, the usual method of refining ale or porter ought to be adopted, before the liquor is committed to distillation. A quantity of isinglass dissolved in water, to which a little sour beer must be added, has the best and quickest effect.

There is another necessary precaution to be observed. Care should be taken that the sediment be not disturbed, in removing the liquor, from the vessel in which it has been fermented, to the still. This may be done, either by a tap at a small distance from the bottom of the vessel, or by the introduction of a syphon.

The *distillation* of the spirit is equally, if not more important than any of the previous processes: for, however good the malt may be, or whatever care may have been taken in the mashing and fermenting, if the distillation be not well conducted, the quantity of spirit will be small, and its quality bad.

To obtain spirit from fermented liquor is the business of the distiller, but to refine and purify it belongs to the rectifier. The second operation is so dependent on the first, that, unless the distillation be carefully conducted, the rectification will be rendered both tedious and difficult.

The

The art of diſtilling malt ſpirit may be reduced to the following principles. 1. To obtain the ſpirit free from the oil of malt. 2. To raiſe the vapours in the moſt œconomical manner. 3. To condenſe them as ſpeedily as poſſible. And, 4, to prevent empyreuma.

The firſt may be done by mixing a ſmall quantity of ſulphuric acid with the waſh; and the remaining three by a proper conſtruction of the ſtill, and the neceſſary care in diſtillation.

The ſtill ſhould be ſo conſtructed as to be capable of containing a column of fermentable matter, conſiderably broader than high, to prevent the liquor at the bottom from being burnt before the upper part is heated. The top ſhould be as wide as the bottom, to give the vapours free and complete liberty to eſcape; which, by the common conſtruction of ſtills, are inceſſantly returned into the boiler, eſpecially at the commencement of the proceſs.

The ſtill recommended by Chaptal is well calculated for the diſtillation of ardent ſpirit. The bottom is concave, in order that the fire may be nearly at an equal diſtance from all the points of its ſurface: the ſides are elevated perpendicularly, in ſuch a manner, that the body exhibits the form of a portion of a cylinder; and this body is covered with a vaſt capital, ſurrounded by its refrigeratory. This capital has a groove or channel

projecting two inches at its lower part within: the fides have an inclination of fixty-five degrees. The beak of the capital is as high, and as wide, as the capital itfelf, and infenfibly diminifhes, till it comes to the worm-pipe. The refrigeratory accompanies the beak or neck, and has a cock at its farther end, which fuffers the water to run out, while it is replaced by other cold water, which inceffantly flows in from above.

When the water of the refrigeratory begins to be warm, a cock is opened, that it may efcape, in proportion as the refrigeratory is fupplied with cold water from above.

The diftillation of the wafh may be kept up, until the quantity limited by act of parliament is obtained; or until the product is no longer inflammable.

Various contrivances have been adopted by the diftillers, to prevent the wafh from burning in the ftill. A bundle of clean fticks is fometimes thrown loofe into the liquor, to agitate the fame during the ebullition. This is more effectually done by a cylinder, fixed in fuch a manner that it will turn by the action of the fteam, and continue a more regular agitation, by means of chains of wood, or metal, connected with the cylinder; but thefe precautions are fcarcely neceffary, if the wafh has been rendered fufficiently limpid.

Rectification

Rectification is ſimple and eaſy, provided the previous operations have been well managed; but, if an empyreuma has been contracted in the ſtill, or the fœtid oil has been combined with the ſpirit, then it becomes more difficult. On the contrary, if theſe have been avoided, nothing more is neceſſary than to mix the ſpirit with an equal quantity of pure water, and recommit it to diſtillation, when it will come over pure.

When the liquor has been burnt in the ſtill, it ought to be kept, for ſome weeks, in charred veſſels; and a quantity of charcoal ſhould be mixed with the ſpirit and water, previous to the diſtillation. This will, generally, be found a ſufficient remedy for empyreuma, but will not correct the diſagreeable flavour communicated by the admixture of the fœtid oil. Many ſubſtances have been uſed for this purpoſe, none of which, I think, are fully adequate to the end propoſed. Filtration has been recommended; but the oil is ſo intimately mixed with the ſpirit, that a conſiderable quantity will paſs through the filter: the operation is alſo tedious, and ſome of the ſpirit evaporates during the proceſs. Alkaline ſalts are frequently mixed with the ſpirit, previous to rectification, ſuch as the carbonate of potaſh, but more frequently the carbonate of ſoda. They, however, are both liable to conſiderable objections, when unaſſiſted by any other ſubſtance; for,

for, although they combine with the oil, and in ſome degree prevent its riſing in vapours, yet they communicate an urinous flavour to the ſpirit, which is highly injurious. Neutral ſalts, quick-lime, calcined bones, and chalk, are equally liable to objection, as they do not effectually deprive the ſpirit of the oil which it holds in ſolution, and an improper flavour is alſo contracted from them.

The method I have adopted, and which is generally attended with the moſt favourable reſult, is the following:

The body of the ſtill is conſtructed like the former, but the capital is ſo formed as to admit of a bent tube into the boiler, or rather into a veſſel connected with the beak and fixed in the boiler, in ſuch a manner as to form a balneum, to be heated by the liquor in the ſtill. From the top of this veſſel an additional beak is continued, ſimilar to that deſcribed in the ſtill for the diſtillation of the waſh, and, like it, connected with the worm in the tub.

The liquor intended for purification muſt be put into the ſtill, with a proportionable quantity of carbonate of ſoda; and, into the veſſel in the ſtill, muſt be put a quantity of diluted ſulphuric acid. After the two capitals are luted, the fire may be lighted, and the vapours will be driven over into the balneum, from which they will regularly riſe with

the heat communicated by the boiling liquor in the ftill. By this means, the oil will remain combined with the alkali, with which it will form a foap, whilft the bad flavour contracted by the alkali will be totally deftroyed; nor will the fulphuric acid be raifed in fufficient quantity to injure the tafte or quality of the fpirit. The fame effects may be produced by inverting the order of the procefs, that is, by mixing the fulphuric acid with the liquor in the ftill, (about two drams to a gallon,) and putting a ftrong folution of carbonate of foda into the veffel in the ftill.

Perfectly pure alcohol may be obtained from the fpirit made by the foregoing rules; but, as the diftillation of alcohol has engaged the attention of many eminent chemifts, I fhall not trouble the Society, either with the method of diftilling it, or with its affinities.

XXXIV.

Fig. 1.

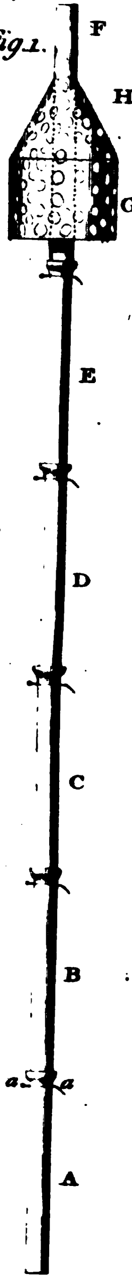
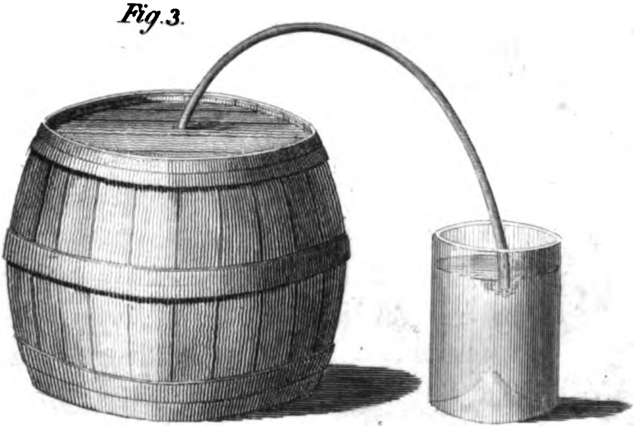


Fig. 2.

Fig. 3.



XXXIV. *Experiments and Obſervations on the Effect reſulting from a Mixture of one Part of Tin with twenty-four Parts of fine or alloyed Gold, when a Plate of the Metal produced by ſuch Mixture is annealed.* *By* M. MATTHEW TILLET.

From the Memoirs of the ACADEMY of SCIENCES of PARIS.

THOUGH it is highly advantageous that ſcientific men, and artiſts of known abilities, ſhould make enquiries in thoſe particular branches of work to which they apply themſelves, and ſhould publiſh their obſervations, yet it ſometimes happens that their reputation (in many reſpects well founded) cauſes the reſults they have drawn from their experiments to be too readily adopted; and thoſe experiments, when carefully repeated, are not always found ſo exact as was ſuppoſed. Not that theſe artiſts, being well informed, and faithful in the account of their operations, meant that they ſhould be looked upon as deciſive; but, by neglecting to conſider the facts preſented to them,

in every point of view, they concluded, too hastily, that those facts were, in all circumstances, such as they appeared to them at first.

Reading the *Journal de Physique* for September, 1788, I observed a paper intitled, Experiments on mixing Tin with Gold *, which I read with great attention, because it is written by a man of great merit and abilities in his profession, namely, Mr. Alchorne, assay-master of the English mint, in the Tower of London. As the object of his experiments is interesting to all artists who make use of gold and silver; as his intention was, to remove any fears they might have, respecting the mixture of a certain quantity of tin with fine or alloyed gold; and as it is still of consequence that those artists should retain their fears, respecting even the smallest mixture of tin with the gold of different fineness which they are continually melting for use, I thought it right to repeat Mr. Alchorne's experiments; and (while I admit the truth of some of the facts he has related) to give an account of those circumstances which I have myself observed, and which, if they had not escaped his observation, would have led him to make some exceptions in the too positive consequences he has deduced from his experiments.

* Mr. Alchorne's paper is printed in our seventh volume, page 26.

Before

Before I give an account of Mr. Alchorne's experiments, and of my own, I think it proper to take notice of the manner in which the editor of the above journal expresses himself, in announcing Mr. Alchorne's paper. He seems convinced that we have, till now, been in an error respecting the essential object of that paper. Consequently that journal, which is deservedly esteemed, and has an extensive circulation, cannot fail to make, in this respect, a strong impression, which ought to be restrained; as it will appear to arise from experiments which were not pursued with sufficient accuracy; and would give an ill-founded confidence to a great number of artists, who work upon the most precious of metals.

It has long, says the editor, been an acknowledged fact, among metallurgists, that tin mixed with gold, even in the smallest quantity, whether in substance or in vapour, totally destroys the ductility of that precious metal; but Mr. Woulfe, Fellow of the Royal Society of London, communicated to that Society, in 1784, a memoir of Mr. Alchorne, assay-master of the English mint, in which he proves, that tin may be mixed with gold, in a moderate quantity, without producing these bad effects. Mr. Alchorne's experiments, he adds, have not been contradicted; yet many of the most respectable authors continue to follow the old opinion respecting the bad

bad effects of tin, though it appears to be totally unfounded. It is therefore fair to ſuppoſe that Mr. Alchorne's memoir is not ſufficiently known or attended to, for which reaſon I think it right to give an abſtract of it here, that it may be more generally known.

Mr. Alchorne ſays, that he had long had doubts reſpecting this extraordinary property attributed to tin; and that, an opportunity offering itſelf, he had made ſeveral experiments upon the ſubject. He mixed twelve ounces of fine gold with different quantities of tin, from ſixty grains to half an ounce. Theſe mixtures were flattened under the hammer, paſſed through the rollers, and ſtamped in the money-preſs, without ſhewing any ſigns of brittleneſs. But, when he mixed one ounce of tin with twelve ounces of fine gold, the metal was brittle, and would not bear any of the forementioned operations. He afterwards expoſed gold to the fumes or vapour of tin; for which purpoſe, he put twelve ounces of gold, of twenty-two carats, into a ſmall crucible, which he placed in a larger one; and, having ſurrounded it with tin, he expoſed the whole to a conſiderable degree of heat, during half an hour; but the gold loſt none of its ductility. He carried his enquiries ſtill farther; he alloyed the forementioned mixtures with copper and ſilver, and afterwards added tin to the gold, thus alloyed with

4 different

different proportions of the above metals. But, in all these cases, even when twelve ounces of gold were mixed with half an ounce of tin and two ounces and a half of copper, the metal bore beating and flattening to the thickness of stiff paper, and of being afterwards made into various small trinkets, or drawn into fine wire, with as much facility as the gold usually employed for that purpose.

Mr. Alchorne observes, that the old opinion, adopted by so many authors, probably owes its origin to the arsenick which tin generally contains, as he found that twelve grains of regulus of arsenick rendered gold harsh and brittle; from which he concludes, that tin, like other inferior metals, is injurious to gold, in proportion to the arsenick it contains; and that there is nothing in tin itself, which can deprive that precious metal of its properties, as has been hitherto supposed.

From this abstract of Mr. Alchorne's experiments and observations, it appears that he affirms, that gold, whether pure or alloyed, when melted with tin, in the proportion of one part of the latter to twenty-four parts of gold, forms a metal which possesses sufficient ductility to bear being hammered, flattened to the thickness of stiff paper, and drawn into fine wire, with the same facility as that gold which is generally used in commerce.

Although

Although I had no doubt that tin deprived gold of its great ductility, or at least rendered it so harsh and brittle that it could not be reduced into thin plates, and still less be drawn into thin wire, unless it was repeatedly annealed, and managed with a degree of care and attention which its usual ductility does not require; nevertheless, I resolved to repeat Mr. Alchorne's experiments, as well out of respect to so able a man, as that I might be able to supply such facts (if any such should occur) as might have escaped his notice.

In my first experiment, I mixed twenty-four grains of fine gold with one of tin; the tin was taken from an ingot of that metal which contained no arsenick. I wrapped this grain of tin in the gold, which was previously reduced into a thin leaf, and rendered very flexible by annealing. I placed these twenty-five grains upon a piece of charcoal, hollowed out in such a manner as to be able to contain them during their fusion. I sprinkled a small quantity of calcined borax over the whole, that it might be more quickly fused, that the two metals might run together, and that the tin, by mixing immediately with the gold, might not have time to be calcined. This mixture, by means of an enameller's lamp, was soon melted, and reduced into a small lump, which had lost nothing of its weight. Being then very

very carefully flattened under the hammer, it cracked, and afterwards broke into three pieces, although, as I ſaid before, I ſtruck it very carefully, and although it was, when it broke, not reduced below a quarter of a line in thickneſs.

I repeated this firſt experiment, upon double the quantity of pure gold and of tin, with a ſimilar reſult: the lump of metal I obtained was brittle, and, like the firſt, broke under the hammer, although I hammered it with great attention, hoping that I might, notwithſtanding its cracks, keep the flattened plate in one piece.

It is hardly neceſſary to mention, that theſe experiments were in ſome meaſure preparatory, and were merely intended to enable me to gueſs at the effects I had reaſon to expect, when I ſhould repeat them on a larger ſcale, and in a manner more ſimilar to thoſe I meant to examine, in order to eſtabliſh a compariſon between them.

I was unwilling to make uſe of gold of twenty-four carats, having good reaſon to fear that it would loſe the advantage of being the moſt ductile of metals, and that I ſhould not be able to reſtore that property to it, but by the operation of parting; I therefore determined to begin my more deciſive experiments upon gold of twenty-two carats, or alloyed with $\frac{1}{12}$ of copper. By ſo doing, I repeated ſome of the experiments of Mr.

 Alchorne,

Alchorne, from which he had concluded, that tin, when mixed in a certain proportion with gold of this degree of finenefs, namely, twenty-two carats, did not deprive the gold of its ductility.

I therefore mixed one *gros* and twenty-four grains of tin, taken from the ingot which, as I have already mentioned, was free from arfenick, with four ounces of gold, the finenefs of which was well known to be of twenty-two carats. Thefe two metals, being reduced into fmall lumps, were put into a crucible, and expofed to a ftrong fire, in a forge, with a double pair of bellows. When they appeared to be completely fufed, I poured the matter into an ingot-mould, of a fize proportioned to the fmall quantity of metal I had to pour into it.

TO BE CONCLUDED IN OUR NEXT.

XXXV.

XXXV. *Account of an advantageous Method of separating the Fossil Alkali from Common Salt. By Mr.* Westrumb.

From Crell's Chemical Annals.

TWENTY pounds of common salt are to be dissolved in sixty pounds of water *; to which solution are to be added, twenty-five pounds of clean dry potash, the larger lumps of which should be first broken. This lixivium is to be evaporated, by boiling, till the saline pellicle, which is thereby formed on the surface, has several times fallen down, and been replaced by a new one. The vessel in which it is boiled is then to be taken from the fire, and the liquor is to stand till it is almost cold, but not quite, that is, till it is about milk-warm. During the cooling, a great quantity of digestive salt will separate from the liquor, which is then to be strained through flannel, so as to be cleared from all sediment.

* A greater quantity of ingredients may be taken, but it must be observed that this process does not succeed when small quantities are used.

When

When the liquor has ſtood in a cold place about an hour, or till it is become quite cold, it will be found to have depoſited ſome more digeſtive ſalt, mixed with mineral alkali. The liquor muſt now be poured off into another veſſel, which is to be placed in a cold ſituation: if the proceſs has been properly conducted, cryſtals of mineral alkali will ſoon be formed, which will be almoſt pure, and in greater abundance than can be obtained by the uſual methods.

The ſaline matter remaining in the ſtrainer conſiſts of vitriolated tartar and digeſtive ſalt. If the liquor is ſuffered to remain upon theſe extraneous ſalts till it becomes quite cold, it will, on account of its oily conſiſtence, be too much incorporated with them; and the quantity remaining on the ſtrainer is too conſiderable to be purified from the mineral alkali, in the ſame way as the other part; for which reaſon, after the matter upon the ſtrainer has been a little preſſed, let ſome warm water be poured upon it, and let it, together with the ſalt which may have cryſtalized after the firſt decantation, be ſubjected to the under-mentioned treatment. The digeſtive ſalt may be made uſe of for various purpoſes, ſuch as making ſal-ammoniac, &c.

When the remaining ley has been poured off from the cryſtalized mineral alkali, it muſt be again evaporated, and, if much digeſtive ſalt ſhould

ſhould appear to be formed, it muſt undergo the ſame treatment as before; otherwiſe it may be immediately ſuffered to grow cold, and the digeſtive ſalt which is depoſited, may be laid aſide, to be afterwards purified.

When the alkaline ſalt is cryſtalized, the remaining ley is to be again evaporated, that all the ſalt may be ſeparated from it. If any ley then remains, it may be ſet aſide for the next operation, or it may be put into a glaſs veſſel, and placed, to evaporate, in the heat of a ſtove, till no more digeſtive ſalt is precipitated, after which the alkali may be ſuffered to cryſtalize in the cold.

By this proceſs, the above-mentioned quantity of common ſalt generally affords twenty-five pounds of impure mineral alkali; and the whole of this operation may very eaſily be finiſhed in ſix or ſeven days.

The digeſtive ſalt obtained in the laſt operation, and the alkali itſelf, are now to be purified in the following manner.

The firſt, that is, the digeſtive ſalt, is to be diſſolved, by boiling in water; the ſolution is then to be evaporated till about half of it is conſumed, and afterwards placed in the cold. The digeſtive ſalt will cryſtalize firſt, upon which will be depoſited the mineral alkali, in large cryſtals, ſo that it may be eaſily ſeparated. By evaporating

porating the remaining liquor a second time, the purification of the digestive salt may be completely finished. If any ley containing mineral alkali should still be left, it may be purified with that which remains at last.

The mineral alkali is to be purified by dissolving it in an equal quantity of water, and letting the liquor stand some days in a cold place. If it contains a large quantity of digestive salt, this salt will appear when the liquor (the first crystallization having been separated from it) is evaporated a second time; at which time may be added that alkali which was obtained in the former purification of digestive salt. If the alkali contains but little digestive salt, this salt will not appear till the third evaporation of the liquor; by which time, if the operation has been carefully and skilfully conducted, almost all the alkali will have been separated.

By the method here described, I have almost always obtained twenty pounds of pure mineral alkali, in large transparent crystals, besides one pound and a half, less pure. The whole process may be finished in twelve or fourteen days, or even in less time, when the different leys are operated upon at the same time, instead of taking them exactly in the order above described.

XXXVI.

XXXVI. *List of Patents for Inventions, &c.*

(Continued from Page 216.)

Abraham Bosquet, of Stangate, in the parish of Lambeth, in the county of Surry, Esquire, formerly of Sandymount, in the county of Dublin, and late one of his Majesty's Commissaries of the Musters; for a method, by the application of which, his Majesty's navy, and all trading vessels, may derive durability, soundness, staunchness, and many other advantages. Dated June 8, 1798.

John Hazledine, of Bridgenorth, in the county of Salop, Iron-founder; for a method of reducing and forming large pigs and pieces of iron, copper, brass, and other metals, into bars, plates, and hoops, of different breadths, sizes, and shapes. Dated June 14, 1798.

Richard Shannon, of Charlotte-street, in the parish of St. Pancras, Middlesex, Doctor of Physic; for a method of improving the process of fermentation, by which, porter, beer, ale, malt,

malt, molasses, wash, wine, cyder, and all other saccharine and fermentable fluids, may be conducted with certainty and success through the various processes of fermentation, in any state of the weather, &c. Dated June 19, 1798.

PATRICK ROONEY NUGENT, late acting surveyor general of lands for the islands of Cape Breton, in North America, but now of London, Esquire; for mathematical instruments, whereby the latitude and longitude, variation and inclination of the magnetic needle, at sea, and on shore, may be obtained in a more general, masterly, and perfect manner, than hath hitherto been done. Dated June 27, 1798.

JOHN PEARCE, the younger, of Wolverhampton, in the county of Stafford, Millwright; for constructing, making, working, and using, combs and machines for combing of wool, in a better manner than any now in use. Dated June 30, 1798.

DAY GUNBY, of Cross-street, Hatton Garden, Middlesex, Carpenter; for weights, bolts, and springs, for improving all kinds of writing and reading desks, tables, chairs, stools, tambour-frames, library-steps, bedsteads, and various other articles. Dated July 6, 1798.

REPERTORY
OF
ARTS AND MANUFACTURES.

NUMBER LIII.

XXXVII. *Specification of the Patent granted to Mr.* JONATHAN HORNBLOWER, *of the Borough of Penryn, in the County of Cornwall, Engineer; for his new-invented Machine or Engine for raising Water, and for various other useful Purposes in Arts and Manufactures, by means of Steam and otherwise.*

WITH TWO PLATES.

Dated June 8, 1798.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, and in pursuance of the said statute, I the said Jonathan Hornblower do declare, that the following is a particular description of the nature

nature of my ſaid invention, both in reſpect to its principles, and alſo the way and manner in which the ſame is performed and rendered practicably uſeful; that is to ſay, Firſt, in reſpect to principles. I admit the ſteam from the ſteam-veſſels or boilers, into certain other veſſels, ſo particularly contrived and diſpoſed as to produce an immediate circular motion round an axis, and thereby communicate a rotary motion alſo, to other parts that may be appended to, or connected with, the machine; without the intervention of that wheel work, and other complicated machinery, which has hitherto been found neceſſary, where motions that are rotative are produced by means of ſuch as are rectilinear and interchangeable.

Secondly. I cauſe the ſteam to operate on certain moveable parts within the aforeſaid veſſels, in ſuch a manner that they occaſionally, and alternately, ſerve the purpoſe of abutments to the force of the ſteam, in one direction, when admitted between them; but, in a contrary direction, are permitted freely to revolve in perpetual ſucceſſion, the one after the other.

Thirdly. Thoſe particular parts of the machine which I cauſe to ſerve as abutments to each other, alſo ſerve the purpoſe of moveable diaphragms or partitions, each having an apartment within itſelf;

ſelf; and, by means of which partitions, I eſtabliſh ſeparate apartments within the body of thoſe veſſels which receive the ſteam from the boiler. Into ſome of theſe there is a conſtant acceſſion of ſteam, and others have open and uninterrupted communication with cold water.

Laſtly. From the practical application of the foregoing principles, as hereinafter particularly ſet forth, I obviate all thoſe inconveniencies attendant on ſuch ſteam engines as are retarded in their operations, from *vis inertiæ*, as often as the direction of their motions are reverſed; and conſequently require both a ſmaller quantity of fuel, and machines of ſmaller dimenſions, for the neceſſary work to be performed.

And, in order for the better comprehenſion and underſtanding how the aforeſaid principles may be reduced to practical uſe, I do hereby farther declare, that although I vary my modes of conſtruction, as a difference in circumſtances may offer, to produce the ſame effect, and obtain the main purpoſe intended, yet I principally adhere to the following method, as being fully anſwerable to what is required, and as beſt calculated to be underſtood from a deſcription of the ſame; that is to ſay,

Firſt. The veſſel in which the ſteam operates conſiſts of a hollow cylinder, compoſed of

two unequal parts, the ſmaller ſection of which is ſcrewed off and on, for the purpoſe of rectifying and repairing the internal ſtructure. Theſe parts are caſt ſeparate, and then ſcrewed together, firm and cloſe, by means of proper margins or flanches for the purpoſe; and in that ſtate the cylinder is bored true from one end to the other. At each end of this cylinder, flanches are alſo caſt, for the purpoſe of ſcrewing on two lids, which are faced true on their ſides next to the body of the cylinder, and the whole will then form a figure ſomewhat reſembling a drum.

Secondly. The lids of this veſſel are perforated in the centres, for the reception of two metalline tubes, which meet in the centre of the drum, and thereby form a hollow axis, through one end of which the ſteam enters the body of the drum, and through the other makes its exit to the condenſing water. On theſe two tubes are fixed two moveable parts of the machine, which I call diaphragms, the nature and conſtruction of which will be beſt underſtood by attending to the annexed figures. (See Plates XIII and XIV.) A, Z, Fig. 6, are the two tubes, which paſs through the central openings in the lids of the drum, meeting each other at B. *a*, *b*, *c*, *d*, are the interior limits of thoſe tubes, on the in-

side of the drum, which are considerably larger than at A, Z, in their diameters; the use of which is, that there shall be a proper cavity at *e*, *f*, *g*, *h*, to receive a packing of tow and grease, or any other materials answering the purpose, between that particular part and the end of the drum; and also that the frames of the diaphragms C, C, may have the firmer holding to the hollow axles or tubes at D, D, leaving the parts of the diaphragm pendent at *i*, *k*. The dotted lines shew the interior limits of the drum, when the diaphragms are in their places; between which and the extremities of the diaphragms there is a proper rabbet, to receive the packing, and as well also between the pendant part of the diaphragms and the central hollow tube about which it revolves. This rabbet is formed by means of plates of metal, screwed on to the frame of the diaphragms, having their edges nearly in contact with the inner surface of the drum, and will be found accessible to repair or renew the packing, when the pannel which constitutes a part of the drum is removed. The parts *e*, *f*, *g*, *h*, may also be repaired at the same time, by means of removing two screws at each end of the hollow tube. (See Fig. 3.) The diaphragms (which are here standing in opposite directions) may therefore freely revolve the one after the other, or one

may

may move, whilſt the other remains ſtationary. The tubes to which they are attached will have their concentricity preſerved, by means of the ſolid axle within the hollow one at E, (Fig. 6,) which is fixed to the end of the tube Z, and paſſes cloſely through a hole in the end of the tube A, till it reaches the extremity at Y; where, by means of a ſecond collar, its central poſition is critically maintained. The two diaphragms are hollow within, and hold communication with the cavities of their reſpective tubes which compoſe the hollow axis; and theſe communications are made by oblong openings, where the diaphragms and tubes are connected together at D, D.

Fig. 3, repreſents the diaphragms and tubes encloſed within the drum, the diaphragms being compleated by having their plates ſcrewed on; in theſe plates are fixed two valves G, G. Oppoſite to which are two others, one in each diaphragm, ſo correſponding that at the opening of one the other is cloſed, and *vice verſa.* Theſe valves are balanced, and held on trunnions, ſo that, in every ſituation of the diaphragms, they may uniformly obey the impulſe by which they are opened and ſhut; the manner in which that is effected is as follows. The two diaphragms widen towards their extremities, in the manner of radii, (ſee Fig. 5,) and may therefore be brought into

into sufficient contact to force open the valves, by means of certain prominent parts in them for that purpose. It should here be noted, that the efforts by which the valves are caused to open take nothing from the power of the machine, because the impulses are reciprocally communicated from one diaphragm to the other, in one common direction.

Thirdly. To explain the manner in which the diaphragms are wrought upon, when in their proper place, let Fig. 5 represent one end of the hollow cylinder or drum which surrounds them, one of the lids being taken away. The central circles exhibit the ends of the hollow tubes which have already been explained in Fig. 6. The two diverging parts are the ends of the two diaphragms, which, as before mentioned, are packed with tow and grease, or other packing, and are furnished with valves; now, these diaphragms being hollow within, if we consider one of them to be constantly supplied with steam, by means of the hollow tube to which it is connected, and the other continually holding communication with the condensing water, the consequence will be, when steam is admitted through a valve into the lesser apartment of the drum, and another valve open from the empty diaphragms into the larger apartment, that the diaphragms will recede from each

each other, with all the force of the ſteam between them; but if, by proper prevention, they can move only in one direction, it is plain that the one will remain ſtationary, till overtaken by the other; their junction will then ſhift the valves into contrary poſitions, by means of the prominent parts in them for that purpoſe, and the apartment before filled with ſteam inſtantly becoming empty, the diaphragm, which was before ſtationary, now becomes active, and the momentum of the former may, in effect, be conſidered as transferred to the latter. There being therefore, in theſe parts of the machine, a continual motion, by rapidly ſucceeding each other in a circular direction, their reſpective axles on which they turn, and which communicate motion to other machinery without the drum, are influenced in the ſame manner, agreeable to the main principles herein primarily ſet forth.

Fourthly. In order that the ſteam ſhall have a power of turning the diaphragms only in one direction, let Fig. 4 repreſent one of the lids of the drum, having the ſide that is faced true on the oppoſite direction to that exhibited in the drawing; in this is a circular channel G G, and a projecting ring P, which ſerves as a perpetual fulcrum to ſupport the two levers C, D, that occaſionally

casionally revolve in the channel, and act as detents. The outer boundary of the channel also acts as a fulcrum to the extremity of the two levers at their thick ends; so that, when they are acted upon, from their connection with the axles turning them to the right hand, by means of a strong collar E, there will be no impediment to their freely revolving in the circular channel; but, when the axles strain upon the small ends of the levers in a contrary direction, they instantly become fixed so firmly, between the two boundaries of the channel, as effectually to resist the whole force of the machine. And, in order that these levers may operate with the greatest advantage, an exact counter-part is provided in the false lids D, E, Fig. 3, which screw on to the drum; and the ring P, Fig. 4, may be supposed to be a part of these lids; by which means, the links which connect the levers and the collars together partly disappear, to shew that both the channel in the inner lid of the drum, and that in the false lid, are partly occupied by the thickness of the lever. To provide against the least retrograde motion whatever, when the levers may be partly worn from friction, they are furnished with springs between them and the outer extremity of the channel, so that the two bearing points may at least touch their respective fulcrums.

Fifthly. By an inspection of the part S, Fig. 3, which I call the tympanum, it will be perceived that there are proper channels, *a*, *b*, for the reception of four levers, similar to those at Fig. 4, which will there also act as detents; two being connected with the hollow axle I, and the other two fixed on the solid axle *w*; so that, as the axles are turned in succession, by the diaphragms within the drum, the tympanum may be continually carried on by one or the other of the detents; and, being firmly connected with the shaft R, both it and the tympanum are uniformly turned, with the whole power of the diaphragms, as long as the steam is admitted between them.

Sixthly. The water that enters the machine for condensing the steam, is extracted by a pump, which may also be made to extricate any air that by accident, or otherwise, may enter the machine; or a separate pump may be made use of for the purpose, after the manner that is commonly practised.

Seventhly. Where a considerable altitude of water can be obtained, I lay aside the use of a pump, and the machine is then calculated in every respect for being wrought by means of water passing through it.

Parts in the drawing remaining to be explained. A, Fig. 3, the brass which receives the end

of the hollow axle, through which the ſteam makes its exit to the condenſing water. This braſs is adjuſted to maintain the central poſition of the pivot, by means of the ſcrew at L, when the machine ſtands erect; but, when horizontally, the ſcrew is fixed at *c*. B, is the opening leading to the pump; that at C opens to the boiler. *o o o o*, the ſpace between the falſe and inner lids of the drum, for receiving the detents, which are collared upon a part of the hollow axle, left octagon in thoſe places. F, a paſſage for the ſteam to enter into the proper diaphragm, paſſing between the inner extremity of the hollow axle and the outer extremity of the ſolid one. Here the due proportion of ſteam that enters is adjuſted by means of a collar of braſs, with rings on it, which is made to move forward and backward, by means of a pinion interſecting the projecting rings, which rings ſerve as teeth, and this pinion is moved on the outſide. (See Fig. 1.) At *d*, Fig. 3, is a hole from the hollow axle into the ſolid one, in order that, when the braſs collar does not admit ſteam enough to keep out the atmoſphere at the ſtuffing collar, a ſufficient quantity may enter by that way, for that purpoſe, into the apartment *o*, Fig. 6, where it will meet the ſtuffing in the apartment *p*, and keep out the air; though it may partly paſs into the diaphragm, where the

 ſolid

ſolid axle nearly fills the hollow one, at *q*. The ſtuffing round this ſolid axle, is ſupplied through two oblong openings at *e*, Fig. 3, covered over by means of a claſping gland V; this claſp alſo ſerves to retain the ſtuffing round the hollow axle at X, which may be repaired, either by taking off the claſp, or through two oblong openings in the iron ſtuffing box at *y*. The air cannot enter the machine at the ſtuffing round the hollow axle, becauſe the ſtrength of the ſteam on the inſide is uniformly the ſame with that in the boiler, or nearly ſo. The end of the ſolid axle has its pivot inſerted into the main ſhaft, where the tympanum is fixed; and the braſſes on which the main ſhaft turns are adjuſted by ſcrews, at any time, for maintaining the central poſition of both the ſolid and hollow axles within the body of the machine. When uſed to produce alternate motions, on the main ſhaft, Fig. 2, is fixed a fly-wheel, at B, in order to regulate the unequal action and re-action, between the rectilinear motion of the pump-work and the circular direction of the diaphragms. In witneſs whereof, &c.

Ex-

EXPLANATION OF THE FIGURES.

(See Plates XIII. and XIV.)

Fig. 1. The machine in an erect position, applied to mill-work.

A. The steam-pipe from the boiler.

B. The drum or hollow cylinder of the machine, in which move two diaphragms.

C. The discharging-pipe, leading to the pump, in the cistern of water D.

E. The rod of the pump, which is moved by means of a crank, where the mill-stones are turned above-stairs.

F. The tympanum, moved by solid and hollow axles through the body of the machine, and thence communicating motion to the wheel G, which moves two (or more) other wheels, H, H, to which are fixed the mill-stones.

Fig. 2. The manner of applying the machine to draw water, or for any other purpose that may require it to work in a horizontal position.

A. The tympanum.

B. The main arbor, which carries the cranks, the shortest of which, at C, works the discharging-pump.

D, D.

D, D. The two cranks over the ſhaft.

Fig. 3. The internal ſtructure of the machine; ſhewing the parts that work within the drum or hollow cylinder; alſo the interior of the tympanum.

Fig. 4. Plan, ſetting forth the conſtruction of the detents, and the manner in which they revolve within the tympanum, and other parts of the machine appropriated for that purpoſe.

Fig. 5. repreſents the diaphragms, as viewed with the drum open at one end.

Fig. 6. ſhews the internal ſtructure of the diaphragms, and their reſpective axles.

Fig. 4.

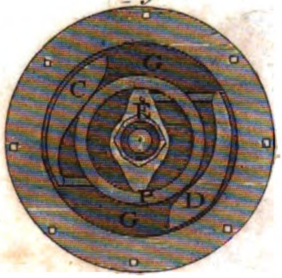
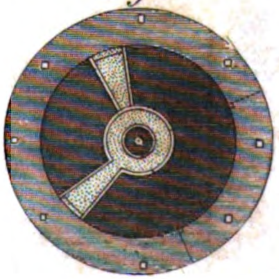


Fig. 5.



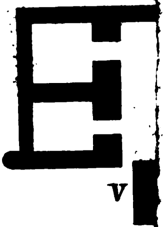
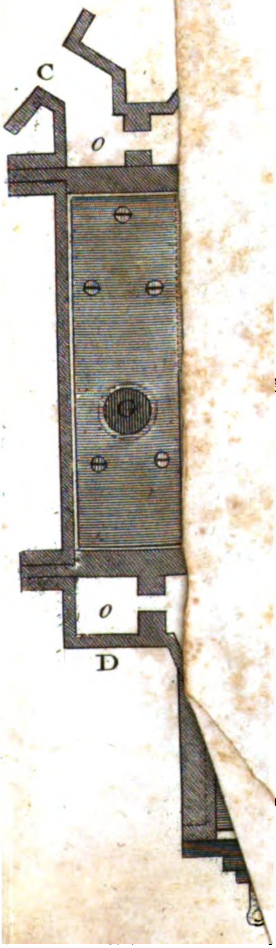


Fig. 3.



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XXXVIII. *Specification of the Patent granted to Mr.* Charles Tennant, *Bleacher, of Darnley, near Glasgow; for his Method of using calcareous Earth, and the Earths Strontites and Barytes, instead of alkaline Substances, for neutralizing the Muriatic Acid Gas used in bleaching; and for employing those Earths in the other Parts of the Process of bleaching, instead of alkaline Substances.*

Dated January 23, 1798.

To all to whom these presents shall come, &c. Now know ye, that in compliance with the said proviso, I the said Charles Tennant do hereby declare, that my said invention is described in manner following; that is to say, this invention consists in a new method of employing calcareous earth, either uncalcined or in the state of quick-lime, for which may be substituted the earth properly called barytes, or that known by the name of strontites, or the earth magnesia, either in their carbonated or calcined forms, though more advantageously in the latter. As all these earths are equally applicable in this invention, it will be sufficient only to specify the way of employing calcareous earth; it being the most abundant

abundant and easiest to be procured, will therefore be generally preferred. The calcareous earth, (in whatever state of its varieties it is intended to be used, and which may be employed almost indiscriminately, although the purer the better,) being calcined and reduced to the state of quick-lime, in order to be employed to the greatest advantage, should be passed through a fine wire-sieve; which will be easily accomplished, if the lime has been previously slaked with a little water. Next, a proportion of this powdered lime is to be put into the receiver, or vessel in use by the bleacher for preparing his bleaching liquor, and where hitherto a solution of alkaline salts, such as pot and pearl ashes, &c. has been in general used, to catch and retain the oxygenated muriatic acid gas; my construction, or form, of which receiver, or of the apparatus in general, I do not condescend upon, that which is at present in general use answering perfectly well. When the ingredients put into the retort, to procure this gas, (whether manganese and common muriatic acid; or manganese, common salt, and oil of vitriol; or indeed any other materials capable of yielding it;) begin to give it out, then it is necessary to keep the liquor in the receiver, which contains the quick-lime, in as constant a state of agitation as possible, so that the fine particles of the lime be diffused throughout the whole of

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the liquor in the receiver, for on this the succefs of the operation depends. I difclaim any right to the difcovery of the fimple chemical folution of lime in water, commonly called lime-water, for retaining and fixing the oxygenated muriatic acid gas, it having been long known that lime-water had fome effect in this way; but, from the quantity of lime that is foluble in water being fo exceedingly fmall, (only about a feven hundredth part of its weight,) no great benefit was found to be derived from it; whereas, by this procefs of keeping the lime in a ftate of mechanical fufpenfion, floating through every part of the fluid in the receiver, it greedily abforbs the oxygenated muriatic acid gas; forming inftantly, as it does fo, a foluble compound, which poffeffes, in an equal or even fuperior degree, the qualities of the bleaching liquor ufually made by the help of an alkaline lixivium, having the very fame whitening and detergent powers, as well as that moft valuable one, of not difcharging dyed colours, but, on the contrary, preferving and enlivening them. I cannot take upon me to ftate the fpecific quantity of lime neceffary to be put into the receiver, for making a given quantity of bleaching liquor, as that muft depend entirely upon the ftrength and other qualities the liquor is wanted to poffefs; however, by ufe of the following proportion of ingredients, a very excellent, and comparatively

paratively very cheap liquor will be obtained, to what can be procured by uſing an alkaline ley, ſtrong enough to abſorb and retain the oxygenated muriatic acid gas produceable from the ſame materials. In a receiver capable of containing one hundred and forty-gallons, wine meaſure, diſſolve thirty pounds of common ſalt, which appears uſeful only in giving an additional degree of ſpecific gravity to the water, and by that means making it eaſier to keep the lime, to be afterwards added, ſuſpended; and for which common ſalt, any other ſubſtance poſſeſſing a ſimilar power may be uſed, and which is itſelf by no means eſſentially neceſſary; when this ſalt is diſſolved, add ſixty pounds of finely-powdered quick-lime; and into the retort of the apparatus put thirty pounds of mangane ſe, mixed up with thirty pounds of common ſalt; upon which, pour thirty pounds of oil of vitriol, previouſly diluted with its bulk of water, and the uſual precaution of luting the veſſel well, &c. taken. When the gas begins to appear, the agitation of the lime and water in the receiver muſt commence; which ſhould be continued, by means of a wooden paddle or rake, of almoſt any conſtruction, without intermiſſion, until the materials are wrought off, (after employing heat as uſual,) and will not yield any more oxygenated muriatic acid gas. Then the whole ſhould be allowed to remain at reſt

rest for two or three hours; when the clear liquor in the receiver may be drawn off for use, and will be found to possess all the qualities before ascribed to it. Although I have mentioned the above proportions of materials, for making bleaching liquor by my discovery, I think it necessary to declare, that these are not the only ones that will be found to answer, as they may be varied with good effects, almost *ad infinitum*, according to the purpose to which the liquor is to be applied. Also, that the spirit of my discovery consists in my having found out that the calcareous earth, and that called barytes, and that called strontites, either in their carbonated or calcined states, by being kept in a state of mechanical suspension in water, or other watery fluid, are capable of uniting with the oxygenated muriatic acid gas, and forming a compound that can be used with great efficacy in bleaching; and also, that these earths, thus mechanically suspended, may be used advantageously in the other parts of the process of bleaching, where alkaline salts have been hitherto employed. From the far greater degree of solubility which the earths barytes and strontites possess, in comparison to lime, I have discovered that a chemical solution of them may be used, with very great effect, in neutralizing the oxygenated muriatic acid, and in other processes of bleaching, instead of alkaline substances;

and that either the mechanical or chemical suspension of these earths may be employed with great success, although the former will be attended with more than the latter. In witness whereof, &c.

The following Information respecting the above Method of bleaching, was sent us by Mr. COUPER, *Surgeon, of Glasgow, who is connected with the Patentee.*

The liquor, prepared as set forth in the specification, has now been fairly tried by many of the principal bleachers in England, Scotland, and Ireland, and is regularly used by them in the course of their business. The saving in ashes, to such bleachers, is very great; and the privilege of the patent has been sold to them for a sum equal to a single half year's saving of ashes derived from using it. It has been found equally useful in bleaching linen and cotton. To the linen and cotton printers, it promises to be of singular advantage, as well in saving of ashes, as in shortening the time for preparing their goods for printing.

The bleachers who now use this process, as well as the patentee, are convinced that it will soon be universally adopted in every process for whitening

whitening vegetable ſubſtances, and will become a great national ſaving, not only by ſaving the aſhes commonly uſed in making bleaching liquor, but by diminiſhing the neceſſity of uſing ſuch quantities in boiling.

The principal point of attention, in preparing it, is to obtain a compleat diffuſion of the lime through the water, that is, a mechanical ſuſpenſion of it in the water, in oppoſition to a chemical ſolution of it, as formerly tried, in form of lime-water. By this means, the oxygenated muriatic acid gas is abſorbed with eaſe, and meets with a ſufficient quantity of lime to produce a ſtrong ſolution of oxygenated muriate of lime, without any uncombined oxygenated muriatic acid, a thing which could not be effected by uſing lime-water alone.

Different forms of veſſels have been uſed for containing the lime and water: either cylindrical, containing an upright ſhaft, with horizontal arms, and turned round by means of a winch; or veſſels of an oblong ſhape, where the agitation is effected by the motion of rakes or plungers, of obvious and eaſy conſtruction. To inſure the more conſtant motion of theſe parts of the apparatus, they have, by many of the bleachers, been connected with the wheel of their plaſh-mill, or other moving machinery neceſſary in their operations.

XXXIX.

XXXIX. *Specification of the Patent granted to Mr.* HENRY JOHNSON, *of London, Gentleman; for a certain Water-Proof Compound, and a Vegetable Liquid; which Liquid is for the Purpose of bleaching, whitening, and cleansing, Woollens, Linens, Cottons, and other Articles; and also for preparing Stuffs or Cloths made of Woollen, Linen, Cotton, or Silk, in order, by the Application of the aforesaid Water-Proof Compound, to render them impenetrable to Wet, and more elastic and durable, when made into Garments, &c. for Wear; which Stuffs I call* Hydrolaines.

Dated July 7, 1797.

TO all to whom these presents shall come, &c. Now KNOW YE, that in compliance with the said proviso, I the said Henry Johnson do hereby describe and ascertain the nature of my said invention, and in what manner the same is to be performed, as follows; that is to say, First, to make the said vegetable liquid, I the said Henry Johnson either take horse-chesnuts, or orange-peels and

and kernels, which are found thrown away after ſqueezing, or the offals and gall of fiſh, or either of them, according to the place where they are to be had. I boil them for four or five hours, and then leave them to cool and ſettle for a few days; or elſe I add eight quarts of water to every pound of a calcined ſubſtance called *Britiſh barilla*, which remains for diſſolution two or three days. To any or either of theſe decoctions, (drawn off fine,) I add one pound of kelp or wood aſhes, refined and purified (by a method well known) to be equal to pearl-aſh, or elſe pearl-aſhes themſelves, to every twenty quarts of any of the above liquids; and, after well mixing and remaining for twenty-four hours, I then ſlake a ſuperior ſort of lime therein, called *Ryegate lime*, in order to give it the caloric, and precipitate the charcoal of the aſhes, and to modify its cauſticity. To this prepared lime, (drawn off fine,) I add the following preparation, *viz.* to every quart of fiſh, linſeed, or any other oil, I put forty quarts of water, and boil it with half an ounce of ſalt of ſorrel, ſalt of ſugar, or rectified ſalt of tartar, which incorporates the oil and the water; and this, after ſettling for twelve hours, I draw off fine; and, to every twelve quarts of the above prepared liquid, I add one quart of this laſt incorporated oil and water; and this, when ſettled, I call *blanching lixivium.*

Secondly,

Secondly, as to the water-proof compound, I proceed as follows: after the linen, woollen, cotton, or ſilk ſtuffs, or cloths, hats, or leather, are prepared by the above-deſcribed *blanching lixivium*, I ſtretch them in a frame; and, having diſſolved caoutchouc or India rubber in ſpirit of turpentine, (the ſmell of which is taken off by oil of wormwood and ſpirit of wine, in equal quantities,) the caoutchouc having become a varniſh, I ſpread it (with a large piece of undiſſolved caoutchouc, inſtead of a ſponge or bruſh) upon the wrong ſide of the prepared ſtuff, cloth, or leather, and then ſift over it any coloured cloth, or ſilk, or worſted, or coney or other wool cut fine, in the ſame manner as flock-paper is made; and, being left to dry for a day or two, this flock, by its adheſion to the caoutchouc, is equal to any lining. In witneſs whereof, &c.

XL.

XL. *Account of the Manner in which Rice is made into Bread, or boiled for the Table, in Carolina. In a Letter to the Editors, from Mr.* JOHN DRAYTON, *of Charles Town.*

South Carolina, Charles Town, July 22, 1798.

GENTLEMEN,

I FIND an account given, in one of your numbers *, of the American mode of making rice-bread. It appears to be more complicated and tedious than that uſed in Carolina; and, as rice is uſed here in an extenſive degree, I hope you will pardon my intruſion, when I endeavour to deſcribe the method by which we adapt this grain to the purpoſes of ſubſiſtence.

The firſt ſtep towards preparing the cleaned rice for bread, is to waſh it thoroughly in water. This is done by putting it into any veſſel, and pouring water upon it; then ſtirring it, and changing the water, until it is ſufficiently cleanſed. The water is then poured off entirely, and the rice placed, in an inclined poſition, to drain. After being ſufficiently drained, it is put, while damp, into a mortar, and beaten to powder; it is

* See our fifth volume, page 350.

then taken out, and made completely dry; and is finally paffed through a common kitchen hair-fieve. The reafon why it is thrown damp into the mortar is, the pulverifing is thereby much affifted, and the labour rendered more eafy.

The rice-flour is kneaded up with a fmall proportion of Indian corn meal, boiled into a confiftence which we term *homony*; or it is fometimes mixed with a few boiled potatoes, to which a fmall quantity of leaven and falt is added. When the fermentation has been fufficiently excited, the dough is put into pans, and placed in the oven, to be baked. By this procefs, a light wholefome bread is made, not only pleafing to the eye, but agreeable to the tafte.

Our manner of boiling rice, for the ufe of our tables, is fimple and expeditious. About half an hour before dinner-time, the rice, being firft wafhed, is thrown into a fmall pot of boiling water, and then boiled, until the grains are foftened and nearly done. The water is then poured off; and the rice, covered up in the pot, remains to fimmer, or more properly to fteam, over a flow fire, until it becomes dreffed to any given degree of moifture or drynefs. The degree which we prefer, is juft when the glutinous quality of the rice ends, and before the deficcation begins.

I am, &c. JOHN DRAYTON.

XLI.

XLI. *Additional Observations on making a Thermometer for measuring the higher Degrees of Heat. By Mr.* Josiah Wedgwood, *F.R.S. Potter to her Majesty.*

WITH A PLATE.

From the Philosophical Transactions of the Royal Society of London.

In my first paper on making a thermometer for measuring the higher degrees of heat *, I communicated every thing that experience had then taught me, respecting both the construction and use of this thermometer; but more extensive practice has since convinced me, that other managements and precautions are necessary, in order to bring it to the perfection it is capable of receiving; for, pieces made of the same clay, and exactly of the same dimensions, have been found to differ in the degree of their diminution by fire, in consequence of some circumstances in the mode of their formation, at that time unheeded, and very difficult to be developed.

* This paper is inserted in our sixth volume, page 255.

 Of

Of the two ways propoſed for forming them, the mould and the preſs, the former was made choice of, as being, for general uſe, the moſt commodious. The ſoft clay was preſſed into a ſquare mould, with the fingers; and the pieces, when dry, were pared down on two oppoſite ſides, by means of a paring gage made for that purpoſe, ſo as to paſs exactly to 0°, at the entrance of the converging canal of the meaſuring gage.

But the pieces thus formed have been found liable, in paſſing through ſtrong fire, to receive a little alteration in their figure, which produces an uncertainty with reſpect to their ſubſequent meaſurement. The two ſides, inſtead of continuing flat, become concave; the edges, both at top and bottom, projecting beyond the middle part, ſometimes very conſiderably, as at *a* and *b*, Fig. 1, (Plate XV.) where A B repreſents a perpendicular ſection of an unburnt piece, and *a b* a like ſection of the ſame piece, after it has undergone a heat of 160 degrees. This irregularity in the form, which is ſenſible only after paſſing through the high degrees of fire, was obſerved in ſome of the early experiments, but was not then looked upon as being productive of any error.

On more attentively examining this matter, it appeared, that when the clay is preſſed into a mould, the ſurface in contact with the mould acquires

acquires a more compact texture than the inner part of the mass; that this compactness restrains, in some degree, its diminution in the fire, and therefore, that when this surface, or less diminishable crust, is pared off from the two sides only, the piece may be considered as having its upper and lower strata (A A and B B, Fig. 1.) composed of a less diminishable matter than the intermediate part; the necessary consequence of which structure will be such a figure as we find the pieces to assume; for, if any stratum in the mass shrinks less than the rest, the extremities of that stratum must be left proportionably prominent. That this was the true cause of the inequality, I was convinced, by firing some pieces *unadjusted*, with all their surfaces entire, as they came from the mould; for these pieces, after passing through the same strong fires with the preceding, continued flat, with the angles regularly sharp, and without the least sensible prominence in any part.

Some of the moulds employed for this use were made of plaster, a material more convenient for the workman than metal, as the pieces part more freely from it, but which contributed greatly to increase the above-mentioned irregularity; for the plaster, by absorbing a portion of the water from the clay contiguous to it, renders the surface, at the same time, even at the instant of contact,

contact, much more *consistent*, and consequently more difficult to press into the angles of the mould; so that the outsides of these pieces were not only more *compressed*, but formed of clay of a different *temper* from the inner parts, being much drier or firmer; a circumstance which, as will appear hereafter, restrains still more their diminution in the fire.

The moulds were therefore laid aside, and the press adopted in their stead; for, as the soft clay, pressed in a cylindrical vessel, gives way and escapes through an aperture made for that purpose, (by which means it is formed into long rods,) the sides of the pieces cannot be supposed to receive so great a degree of compressure against the sides of the aperture through which it is *delivered*, in this operation, as it does against the sides of the mould, by which it is *confined* till every part has born a pressure sufficient to force the clay into every angle, which is much greater than even a workman would imagine, till he comes to try the experiment himself.

But, with this change, some new difficulties arose; for, pieces pressed through the same aperture, and from the same press-full of clay, and adjusted, when dry, to the same point in the gage, were found, after passing together through the same strong fires, to differ in their dimensions from one another, in some instances, more than any of the preceding.

Having

Having hitherto paid no particular attention myself to the mere manual labour of pressing the clay, I determined, upon this event, to go through that and every other operation, however simple and seemingly insignificant, with my own hands.

In doing this, I observed, that the power necessary for forcing the clay through an aperture which bore but a small proportion to the diameter of the mass of clay in the press, was so great as to squeeze out, along with the clay that first passed through, a considerable portion of the water that belonged to the rest. From this over proportion of water, in the composition of the first pieces, they were soft and spongy, and the succeeding ones more and more compact, till at length the clay proved so stiff as scarcely to be forced through at all.

Clay containing different proportions of water, is well known to diminish differently in drying; but, it was not imagined that, when dry, there would be any difference in its subsequent diminutions by fire. Experiments, however, multiplied in a variety of circumstances, shewed decisively, what the pieces formed in the mould had given grounds to suspect, that those formed of the softest clay, and which had undergone the least pressure, diminished most in burning; and that the diminution is uniformly less

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and less, in proportion to the greater degree of pressure or compactness.

The knowledge of the cause of the irregularity suggested a remedy. I lessened the width of the press very much, so as to bring the diameter of the mass of clay, and that of the aperture through which it is delivered, to a nearer proportion with one another. A much less degree of force being now sufficient, the pieces or rods were proportionably more uniform, though there was still a sensible difference, in consistence, between those which were first and last pressed out from the same mass of clay. The intermediate ones, within a certain distance from the two extremes, corresponded very nearly with one another; so that, by rejecting a sufficient number of the first and last, and using the *intermediate ones only*, the inequality may be considered as almost annihilated.

I nevertheless still found that, in strong fire, the edges became a little prominent, though not so much as before. I was aware that these pieces must partake, in some degree, of the imperfection of those made in the mould; having their surfaces rendered, by their friction against the sides of the aperture, more compact than the inner part. But I suspected that something might depend also upon the *form*, and accordingly made many trials for ascertaining the form that might be least liable to this irregularity. The angles only

were bevelled off; the sides were rounded; the pieces were rounded all over; made of ovals and other curves; and both the longest and shortest dimensions were used as the extent to be measured. The general result was, that the nearer they came to a circular figure, the less inequality they contracted in the fire; and, by making them entirely circular, the imperfection appeared to be obviated altogether; cylindric pieces bearing the strongest fires, without the least appearance of prominence or inequality in any part of their surface. I have therefore chosen this last form, leaving only one narrow flat side, (*a b*, Fig. 2.) as a bottom for the pieces to rest upon, and to distinguish the position in which they are to be measured in the gage.

I have endeavoured, at the same time, to obviate whatever inaccuracy the inequality of compactness may be capable of producing, by so adjusting the aperture through which the rods are pressed, and on which their figure and dimensions depend, as to supersede the use of the paring gage altogether; that the whole surface may remain of the same uniform compactness which it received in the press. And, as it is scarcely practicable, in any mode of forming soft clay, to have all the pieces precisely of the same dimensions after drying, I do not reject those which come within two or three degrees of the standard;

ſufficient to reach ſome way above the fuel, nearly the whole range of the thermometric ſcale may be produced in one rod: an ocular proof, not only of the diverſity of heat within a ſmall compaſs, but likewiſe of the peculiar ſenſibility of this thermometer; every part of the maſs expreſſing diſtinctly the degree of heat which it has itſelf felt. It will be proper, in this experiment, to have a tube fixed in the bottom of the crucible, for keeping the rod ſteady, as at Fig. 4. By this means, the heat of my air-furnace renders a rod of the thermometric clay tapering, from about four parts in diameter at top to three at bottom; which are nearly the proportions between the width of the piece when unburnt, or but juſt ignited, and when it has ſuffered a heat of 160 degrees.

To the foregoing ſources of inequality in the pieces, one more may be added, *viz.* ſmall cavities or air-bubbles, accidentally incloſed, which ſometimes happened in the earlier experiments. In order to prevent theſe, particular attention is now paid by the workmen to what we call *handling* or *ſlapping* the clay, an operation by which its different parts are intermixed, and the maſs rendered of an uniform temper throughout. The workman takes a lump of the clay in his hands, perhaps of two pounds weight, and, breaking it in two in the middle, lays one part upon the other, and

and presses them flat again, repeating this forty or fifty times, or perhaps oftener. Now, considering the pieces at first as two dissimilar masses, with any number of air-bubbles inclosed, each of these pieces being by the first doubling divided into two, by the next into four, by the third into eight, and so on in geometrical progression, each of the original masses will be divided by the fiftieth repetition, into upwards of eleven thousand millions of millions of invisible laminæ; invisible, because the lump of clay would, long before the last doubling, be of one uniform colour, though at first one half of it had been black and the other white. If therefore no air be inclosed between the pieces, at the times of their being put together in this process, all the air which might have been in the mass before would certainly be driven out; and, to avoid as much as possible the introduction of any fresh portions of air, the two separated pieces are each time made smooth, and a little convex, on the surfaces that are to be brought together.

By due attention to the circumstances above stated, any single quantity of clay may be made up into thermometer-pieces, that shall differ very little, if any thing at all, from one another.

But a new difficulty now arose, more embarrassing than any of the former; that of procuring fresh supplies of clay, of the same thermometric quality

quality with the firſt. The quantity of the clay which, after trial of many others, I had made choice of, was ſmall; but the particular ſpot it was taken from being known, and having purchaſed the little eſtate in which it was raiſed, I had not a doubt of obtaining more of the ſame, when it ſhould be wanted: for clays in general, when raiſed from an equal depth, in the ſame ſtratum, and near the ſame place, are found to poſſeſs the ſame properties, with reſpect to ductility in the hands of the workman, a diſpoſition to aſſume by fire a porcelain or vitreous texture, ſingly or in compoſition, and all other qualities relative to their uſe in pottery. In this, however, I was deceived; for, when a freſh ſupply was wanted to complete my experiments, though I had ſome taken from a pit joining to the firſt, and at the ſame depth, it was found to diminiſh differently from the former parcel. I then had ſome raiſed from different parts of the ſame field and bed, and at different depths; and in various other places in Cornwall, from the ſpot where this ſpecies of clay is firſt met with to the land's end. But all theſe clays differed ſo much from the firſt, in the quantity of their diminution by fire, and moſt of them likewiſe from each other, that I deſpaired of being ever able to find one that would correſpond with it, or any natural clays that could be obtained twice of exactly the ſame

same *thermometric* properties, how similar soever in other respects.

Upon a review of the numerous comparisons which I have made of these new clays, in different degrees of heat, from the commencement of redness up to intense fire, the most striking differences of the greatest part of them, from the old, seemed to originate in the lower stages of heat; and, of those which were got from the neighbourhood of the old, the variations from it, in the higher stages, seemed, for the most part, to be only consequences of those differences in the lower ones.

I have mentioned, in my first paper, that the original thermometer-pieces had their bulk enlarged a little on the approach of ignition; but that, by the time they became visibly red-hot throughout, they were reduced to their former dimensions again, and at this moment the thermometric diminution begins. The new clays had their bulk enlarged in a much greater proportion, and the enlargement was of much longer continuance. Some of them required a heat of fifteen degrees, to destroy the increase which ignition had produced in their bulk, and bring them back to their original dimensions; after this period, most of them diminished pretty regularly, and uniformly with the old, being nearly so many degrees behind it, in all the succeeding stages of heat,

heat, as they required to bring them back from the enlarged ſtate.

I have mentioned alſo, in my former paper, that a quantity of air is extricated from the clay, moſt rapidly at the period in which the augmentation of bulk takes place; and that the augmentation was probably owing to this air forcing the particles of the clay a little aſunder, previous to the inſtant of its eſcape. It was therefore preſumed, that the greater extenſion of theſe new clays might be owing, either to a greater quantity, or ſtronger adheſion, of this combined air; and, as clay kept moiſt for a length of time, in certain circumſtances, undergoes a proceſs ſeemingly analogous to fermentation, it was hoped that, by ſuch a proceſs, part of its combined air might be detached.

But experiments made on this idea have proved, that theſe clays, kept moiſt for a twelvemonth,—kept for a conſiderable length of time in a heat juſt below viſible redneſs,—boiled in water for many hours,—alternately and repeatedly moiſtened and dried,—ſuffer no alteration in their thermometric properties, and continue to differ from the ſtandard clay, juſt as much as they did at firſt.

Some of theſe new clays differed from the old in a property ſtill more eſſential, and by which I was much more diſconcerted; for, though they continued

continued diminishing with tolerable regularity, keeping only some degrees behind it, up to a certain period of heat, about that in which cast-iron melts; yet many of the pieces, urged with a heat known to be greater than that, were found not to be diminished so much as those which had suffered only that lower heat. Farther experiments shewed, that after diminishing to a certain point, they begin, upon an increase of the heat beyond that point, to swell again: and, as this effect is constant in certain clays, and begins earliest in those that are most vitrescible, and as clays are found to swell upon the approach of vitrification, I look upon this second enlargement of bulk, however inconsiderable, as a sure indication of the clay or composition having gone beyond the true porcelain state, and of a disposition taking place towards vitrification; which stage is always, so far as my experience reaches, attended with a new extrication of air; and, in some instances, this air being unable to make its escape from the tenacious mass that envelopes it, the burnt clay is thereby so much encreased in bulk as to swim on water, like very light wood. The degree of heat, therefore, at which this enlargement begins, may be considered as a criterion of the degree of vitrescibility of the composition; which points out a new use of this thermometer, enabling us to ascertain the *degree of*

vitrefcibility of bodies that cannot actually be vitrified by any fires which our furnaces are capable of producing.

All my refearches among the natural clays proving fruitlefs, and the experiments having fhewn, that all thofe which could fufficiently refift vitrification diminifhed *too little* in the fire, I endeavoured to find a body poffeffed of the oppofite property, that is, diminifhing *too much*, and, by a mixture of thefe two, to produce the *medium* diminution required. As I could not find any natural fubftance poffeffed of that property, which would not at the fame time render the compound too vitrefcible, I was obliged to have recourfe to fome artificial preparation; and, as the earth of alum is the pure argillaceous earth, to which all clays owe their property of diminution in the fire, poffeffing that property in a greater or lefs degree, according to the quantity of alum-earth in their compofition, I mixed fome of this earth with the clay, and found it to anfwer my wifhes completely, both in procuring the neceffary degree of diminution, and increafing its unvitrefcibility. So little is this compound difpofed to vitrification, that the greateft heat I could give it, that of 160°, did not even bring it to a porcelain texture, but left it ftill bibulous; and, as it does not arrive at the *porcelain* ftate, in this fire, there can be no danger of its approaching

too

too near to the *vitrescent*, in any heat that we can produce in a furnace.

In order to obtain the exact medium required, I took one of the best of the clays I had procured from Cornwall, and mixed it with different proportions of the alum-earth, till the composition was found, on repeated trials, to agree with the original in all degrees of heat. This coincidence was not indeed essential; but, as many degrees of heat were already before the public, measured by thermometer-pieces made of the first clay, and as the correspondence of the first with Fahrenheit's scale had likewise been in some measure ascertained, it was desirable that the same degrees of heat should continue to be expressed by the same numbers.

The alum-earth is prepared for this purpose by dissolving the alum in water, precipitating with a solution of fixed alkali, and washing the earth repeatedly, with large quantities of boiling water. When the earth has settled, the water above it is let off by cocks in the sides of the hogsheads; and, when the vessels are filled up with fresh water, care is taken to stir up the earth from the bottom, and mix it thoroughly with the liquor. I find it most convenient to use the earth undried, in its gelatinous state, as, in this state, it unites easily and perfectly with the clay; whereas, when the alum-earth has concreted into dry masses,

 great

great labour is neceſſary to mix them uniformly together.

I have tried ſeveral different parcels of Engliſh alum, from the ſame and from different manufactories, and found no material difference in the quantity of earth it contains *. Nor indeed would it be of any conſequence, if there was a difference in this reſpect; as the proportion of alum-earth neceſſary for different clays, and even for different parcels of the ſame clay, can only be aſcertained by repeated trials, adding ſucceſſive quantities of the earth till the deſired effect is found to be produced. Ten hundred weight of the Cornwall porcelain-clay which I have now in uſe, required all the earth that was afforded by five hundred weight of alum.

It is material in this place to obſerve, that the earth of alum is extremely tenacious of water, inſomuch that, though apparently dry, the water and air amount to near as much as the pure earth, and are not to be completely driven out,

* A difference in the quantity of earth may ariſe from different proportions of Glauber's ſalt and vitriolated tartar, of which I have found quantities very conſiderable, but nearly alike, in all the Engliſh alum I have examined. Theſe ſalts are doubtleſs formed by the kelp aſhes employed in the preparation of the alum. They are diſcovered by calcining the dried alum with charcoal-powder, which decompoſes the alum only, leaving the two other ſalts intermixed with the alum-earth, whence they may be extracted by water.

without

without a full red heat. When divided by the admixture of other earthy bodies, it parts with its water easier indeed than before; but a mixture containing so much of it as the thermometric composition does, is far more retentive of water than common clay, and requires to be kept for some time in a heat equal to that of boiling water, before it is to be considered as dry, that is, before the adjustment of the pieces in the gage. If they are adjusted when only apparently dry, or of such a degree of dryness as they can be brought to by a heat that the hand can bear, the heat of boiling water will diminish them two or three degrees; and, the greatest part of what they have thus been deprived of, they gradually recover again on being exposed to the atmosphere, so that the adjustment must be made immediately after the boiling heat.

By the same expedient to which I have thus been obliged to have recourse, for procuring to the porcelain-clay of Cornwall the standard degree of diminution and resistance to fire, the same qualities may probably be communicated to any other clay that is tolerably pure from calcareous earth and iron; so that the thermometer clay is no longer to be considered as the produce of any particular spot, (which was the principal inconvenience originally imagined to attend it,) but may be procured and prepared in all parts of the

the world, where good common clay and alum are to be found; and *correſpondent* thermometers may conſequently be conſtructed, without any ſtandard to copy from. For, if a converging canal be formed, of any convenient length, with the widths at the two ends in the proportion of 5 to 3, with the ſides perfectly ſtraight, and divided into 240 equal parts, numbering the diviſions from the wider end *; and, if a clay be obtained of ſuch quality that, when formed, in the manner already mentioned, into pieces of ſuch ſize as to enter to 0 in the gage or canal, theſe pieces ſhall juſt begin to diminiſh, or go a little farther in the canal, by a heat viſibly red; go to 27, by the heat in which copper melts; to about 90, by the welding heat of iron; to about 160, by the greateſt heat than can be produced with coaked pit-coal, in a well-conſtructed common air-furnace, about eight inches ſquare, ſtill continuing bibulous, ſo as to ſtick to the tongue; ſuch gages, and pieces of ſuch clay, ſo adjuſted, will always compoſe correſpondent thermometers.

Having mentioned occaſionally ſeveral alternate periods of dilatation and contraction in clay, it may be proper to ſtate, and bring into one view,

* Or the diviſions on the ſide may be continued to 300; and, in that caſe, inſtead of the widths of the two ends being in proportion to the odd numbers 5 and 3, the one will be juſt double to the other.

the

the whole succession of changes which I have observed in this curious material; as otherwise they might create some confusion in the minds of those who have not had occasion to think attentively on this subject, and lead them to ask, how a body so variable, and liable to such opposite changes from different degrees of heat, can yet be a just measure of those degrees.

The changes which take place in all the natural clays that have come under my examination, are six.

1. The first is, the *shrinking* of the moist clay, in drying, from the mere loss of its water. The purer the clay is, the more water it requires to soften it, and the more it diminishes in bulk, by the loss of that water.

2. The dry clay, gradually heated, preserves its bulk unvaried, up to the approach of ignition. At this period, it is *enlarged* a little; probably, as already observed, from its combined air endeavouring to escape.

3. When this air has made its escape, the clay begins to diminish, or to *lose the bulk it had before acquired*; and returns back, sooner or later, to the same dimensions which it was of when dry. It is at this point, that the thermometric diminution commences.

4. From this point, the clay continues to *diminish* more and more, in proportion as the heat is

encreafed. This I call the *thermometric ftage** of diminution; it is of greater or lefs extent, terminating at different periods of heat, according to the nature of the clay. In the ftandard thermometer clay, it commences with vifible ignition, and continues to (and doubtlefs far beyond) the extreme heats of our furnaces; an interval confifting of 160 degrees of the fcale. In others, it begins 4, 6, and in fome even 15, of thofe degrees later, and terminates alfo much fooner: and in fome. its whole extent is not above 20 of the fame degrees. Throughout the greateft part of this ftage, the clays are found to retain their property of fticking to the tongue and imbibing water: between this *bibulous* ftate and the *vitrefcent*, there is an intermediate one, diftinguifhed by the name of *porcelain*; and, to the higher term of this porcelain ftate, the ftage of thermometric diminution feems to continue.

5. When the clay has paffed the porcelain ftate, it begins to be *enlarged* again; a fymptom of the vitrefcent ftage being commenced; and in this period it fwells more or lefs, according to the nature of its compofition.

6. By farther heat, the fwelled mafs, becoming fluid, fubfides; is converted into glafs or flag; and *contracted into lefs volume* than the clay occupied in any of its preceding ftates.

It

It is plain, therefore, that clay can be a measure of heat no farther than from ignition, or that point beyond ignition where the third stage terminates, to the beginning of the vitrescent stage; and that, as the three first changes are completely passed before the clay is applied to thermometric purposes, being strictly no other than preparatory processes, the thermometer-pieces, whatever *clay* they may be made of, (provided it is sufficiently unvitrescible,) are to be considered as possessing only the fourth stage. But a singular property of the *composition* of clay and alum-earth remains to be mentioned, *viz.* that it has really no other than this one stage: it suffers no enlargement of its bulk at ignition, or in any other period, but proceeds in one uninterrupted course of diminution, from the soft state in which the pieces are formed, up to the extreme fires of our furnaces. Though the diminution, however, is uninterrupted, it is at the same time so inconsiderable at the beginning, from the heat of boiling water (at which the pieces are adjusted) up to ignition, that the same point of visible redness is taken for the commencement of the scale, in this, as in the original clay, without any sensible error, or variation in their progress.

I am inclined to believe, though experiments have not yet enabled me to speak with certainty on this point, that the same cause which enlarges

the *natural clays*, on their firſt expoſure to the fire, operates alſo in this compoſition, but in a much lower degree; and that, while the *natural clays* have their whole maſs diſtended by the efforts of the air in forcing its paſſage, the *compoſition* is only reſtrained in its diminution, or prevented from diminiſhing ſo faſt as it otherwiſe would do, and as it is found to do in the ſubſequent part of its courſe, after the air has eſcaped from it.

As the compoſition of clay and alum-earth is far more tenacious of water than the clay itſelf, and was found, after being dried by the heat of boiling water, to yield, by diſtillation in a retort, above three times as much aqueous fluid as the original thermometric clay did, it ſeems probable, that a part of this water, retained to the approach of ignition, and in a ſtate of chemical combination, may facilitate the paſſage of the air; ſerving as a vehicle to convey it off, through interſtices not permeable to air alone, and conſequently enabling it to eſcape, without doing that violence to the maſs which the natural clays ſuſtain from the expulſion of their air after the water has been detached from it; for the experiments of Dr. Prieſtly have ſhewn, that veſſels, even of burnt clay, are permeable to air, when they have imbibed water into their ſubſtance, though not at all ſo in a dry ſtate.

XLII.

Fig. 3.

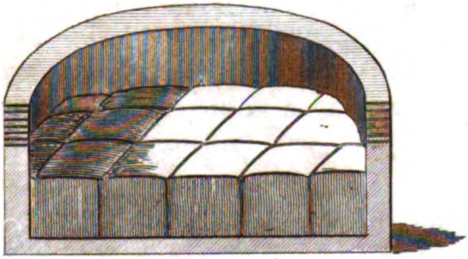


Fig. 1.

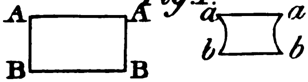


Fig. 4.

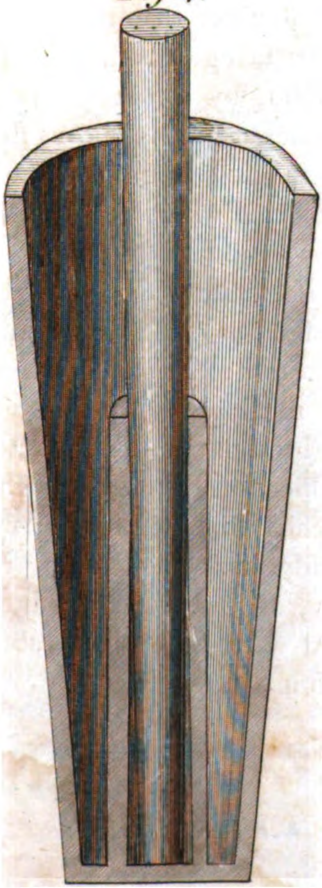
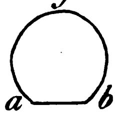


Fig. 2.



XLII. *Obſervations on the Conſtruction of Ships.* *By Sir* George Shee, *Bart. M. R. I. A.*

From the Transactions of the Royal Irish Academy.

I WAS firſt led to ſuſpect that the conſtruction of ſhips built in Europe admitted of improvement, by obſerving, that veſſels employed on the river Ganges, and on different coaſts of India, carried great burdens, in proportion to their dimenſions; and, on examining them, I found that, however widely they differed from each other in appearance, great expanſion was common to them all. The veſſels of the Ganges, it is true, being conſtructed to move at times in ſhallow water, were not, I found, well calculated to ſail near the wind; but this defect I knew could be remedied; and it was ſufficient for my purpoſe to aſcertain the fact, that, when heavily laden, they could be moved with greater velocity than veſſels on the European conſtruction, of the ſame burden, could be by an equal impulſe, with ballaſt only on board.

The opinion I had thus formed was ſtrengthened, in the courſe of a voyage I made from Bengal to England. ~~Obſerving that~~ the Rodney, a company's ſhip, which I was on board of, appeared longer, and ſailed faſter, than other Indiamen, I made enquiry as to her conſtruction; and was informed that, on laying her keel, ſhe had been intended for a ſhip of much more conſiderable burden, but that, owing to a temporary ſcarcity of timber, all her dimenſions had been abridged, except that her length was ſuffered to remain, and conſequently to exceed, by ſome feet, the uſual proportion. On our arrival in the channel, with the wind about a point before the beam, we overtook a fleet of Weſt Indiamen, and we out-ſailed them with ſuch facility, that they might almoſt have been ſuppoſed water-logged.

Theſe obſervations, with many others, led me to beſtow more attention than I had before paid, to an examination of the mechanical principles applied to the building of ſhips; and, the more I extended my enquiries, the more I was convinced that their conſtruction was defective. Had, however, my concluſions not been ſtrengthened by previous obſervation, I ſhould not have thought them worthy attention; for I am myſelf ſo much an Infidel in theoretic ſyſtems in general, that I offer conſiderable violence to my mind whenever I ſubſcribe to their truth, unleſs con-

firmed by something like experimental proof; and I should not therefore expect from others much attention to remarks merely theoretic.

A glaring defect in ships employed in transporting merchandize is, that they draw too much water, or are constructed too deep. It is well known that every floating body propelled, must, in its progress, displace a body of water equal in weight to itself, and equal in bulk to the part situated below the surface; and that this operation must be repeated, as often as the body moved advances a distance equal to its own length. Now, as the line of least resistance from the water displaced is upwards, it follows, that the force necessary for its removal must be great, in proportion to the distance of any part of it from the surface; and hence arises the facility with which vessels drawing little water are moved, even when the burden they carry is considerable.

Another defect in merchant vessels is, that they are too short. The progress of a ship that wants length is impeded by perpetual ascent and descent, even in water but moderately agitated; while one that has it proceeds with little more than direct motion. But this is not the only objection to want of length. The tendency of the upper sails of a ship is, not only to propel horizontally, but in a very considerable degree to press down the head and elevate the stern, as will appear

appear evident, when it is considered that the maſt is acted upon as a lever; the upper deck is the fulcrum, and the parts above and below it the two arms. Now the action of the wind that fills the upper ſails is nearly upon the point of the long arm, and the degree of reſiſtance to the depreſſing force ſo cauſed, is determined by the length of the line from one extreme horizontal point of the ſhip to the other; when therefore this line is ſhort, in proportion to the height of of maſt, the effect is not only evident in a high or ripling ſea, with the wind fair and ſtrong, but, even in ſmooth water, the veſſel, particularly if ſmall, proceeds with evident deviation from the horizontal poſition which her hull is intended to preſerve, as well when in motion as at anchor; and, by this means, the points of direct reſiſtance are multiplied, as the height of the frothy wave at the bows of ſuch veſſels in their progreſs, or the diſproportion of that wave to their velocity, ſhape, and ſize, evidently ſhews.

A third defect, not leſs ſtriking than theſe, is that the veſſels I mention are too narrow. A few feet of length add little to the ſize of ſhips, as to burden, but a ſingle foot in breadth increaſes prodigiouſly their capacity to ſuſtain weight. The ſhape of merchant veſſels in general may be ſaid, from its tendency, to reſemble an extended wedge, perpendicularly placed; every ton additional

additional weight preffes them down confiderably, and, from the practice of overloading them, in order to proportion their burden to their failing, charges, and original coft, they commonly proceed on a voyage almoft buried in the water. To this circumftance alone, the lofs of numbers of them may be afcribed; for a captain muft be pofitive that the danger is exceffive, before he can hold himfelf juftified in attempting to lighten the fhip; and, in fituations the moft perilous, this is often found impracticable.

The remedy for thefe defects is eafily ftated, but the practicability of applying it requires explanation; as inveterate prejudices in the minds of fhip-builders are to be oppofed, and ftrong prepoffeffions, in the minds even of men of fcience, who have thought mechanics deferving their attention, to be combated.

To give fhips great horizontal expanfion, in proportion to their depth, which I conceive effential to the perfection of their form, the conftruction of their hulls, in other refpects, muft undergo a change. The bow and the fides are, or rather ought to be, conftructed upon principles directly oppofite. The one is to break through the water; the other to refift all force that gives the body of the veffel a difpofition to lee-way. The perfection of the former is, to have as few points of direct refiftance as poffible; that of the latter,

latter, it would ſeem, to preſent as many; muſt it not then, to an unprejudiced obſerver, appear extraordinary, that both parts ſhould be compoſed of ſegments of circles; ſcarcely a ſuperficial ſquare foot of the largeſt ſhip's ſide, below the water-mark, lying perpendicular to horizontal preſſure? The keel, in fact, with ſome ſmall extent of plain immediately above it, ſpringing from the bottom, are truſted to for reſiſtance; but theſe are, in moſt caſes, inſufficient; few veſſels, except frigates, and others of extraordinary length, being found to ſail well upon a wind.

An argument, univerſally uſed by ſeamen and ſhip-builders, in ſupport of the preſent conſtruction as to depth, is, that what they technically call "a gripe of the water below the power of the ſurge" is eſſential in preventing veſſels from being driven to leeward. As this argument ſtrikes directly at the root of any improved ſyſtem founded on expanſion, it is neceſſary that it ſhould not remain unanſwered.

A gripe below the influence of the ſurge, if it means any thing, implies reſiſtance to the force of waves beating againſt a ſhip's ſide. Now, ſuppoſing this reſiſtance poſſible, the firſt high ſea that ſhould ſtrike her on the beam, in a gale of wind, would inevitably either overſet or deſtroy her, by forcing in her ſide; the ſecurity therefore of

of ſhips, in numberleſs caſes that conſtantly occur, depends on their yielding to the force of the waves. Admitting, however, for argument ſake, that, in ſtorms, the dexterity of ſeamen may prevent a ſhip from being expoſed to the violence of the ſea upon her broadſide, let us ſee how, in moderate weather, the deep gripe can operate.

Waves, I believe, are not thought to run very high, when they riſe from ſix to ten feet above the water-level, that is, from twelve to twenty above the trough of the ſea; there are few ſhips whoſe draught of water exceeds twenty; is it not evident then, that veſſels, through all gradations of ſize, even on their preſent conſtruction, are in general completely expoſed to the power of the ſurge.

But, as experiment ſuperſedes arguments, any perſon in whoſe mind doubt exiſts upon this ſubject, may ſatisfy himſelf by viewing a ſmall cutter, when ſailing upon a wind, in company with large ſhips; or by obſerving a wherry, which draws ſtill leſs water, working to windward: nay, even a ſhip's long-boat, the moſt flat of all ſea veſſels, may ſerve to convince him, that he may diſmiſs thoſe doubts, without running much riſk of falling into error, and ſatisfy him that, provided a veſſel have hold of the water proportionate to her ſize, it is of little moment whether the gripe be near to, or remote from, the ſurface.

TO BE CONCLUDED IN OUR NEXT.

XLIII. *Conclusion of* M. Tillet's *Experiments and Observations on the Effect produced by mixing Tin with Gold.*

(From Page 282.)

THE ingot I obtained from this fusion, had scarcely lost any thing of the weight of the two metals I had employed; a circumstance which served to prove, that the tin had completely incorporated with the four ounces of gold with which I had mixed it. But, when I attempted to bend the ingot, which was about six inches in length, and not above two or three lines in thickness, I remarked that, contrary to the usual nature of gold of twenty-two carats, it was rigid, and would have required a pretty considerable effort to bend it and strengthen it again, in the manner which might have been easily done, if there had been no tin in its composition. I immediately saw that this harshness intimated a diminution of its ductility, and that the introduction of a substance which was foreign to the gold, and

of a nature incapable of maintaining its cohesion, was the cause of this defect in flexibility; which defect could only be attributed to the tin, because copper alone, when mixed with fine gold, (though it gives the gold a degree of hardness and consistence which it does not naturally possess,) takes from it scarcely any of its ductility.

After this first observation of the state of the ingot I had obtained from my experiment, I proceeded to a more decisive trial, *viz.* that of forging the ingot, and examining what would happen to it when beat with the hammer, and particularly with the sharp part of it, in such a manner that the metal might be extended, and by that means undergo the strongest trial. I did not observe that by this operation (which was continued until the ingot was reduced to about two thirds of its original thickness) the edges of the bar were at all cracked, or that it yet shewed any great signs of brittleness; but, as I feared that this accident would happen, if I continued to hammer it for a longer time, I cut off that part of the bar which I had beat out with the edge of the hammer, and afterwards placed it between lighted charcoal, in order that, by being moderately annealed, it might be restored to the degree of malleability it possessed before it had been hammered.

 But,

But, when I went to take it out of the fire, where it had undergone no greater degree of heat than that of a cherry-red, I found it divided longitudinally into two pieces. After letting them cool, I hammered them again. They were extended with tolerable eafe, but with fome cracks at the edges. I was not fatisfied as to what I had farther to expect, and therefore annealed only one of the two pieces I had twice hammered, and kept the other piece in its hardened ftate, in order to pafs it, in that ftate, through the rollers. The piece I annealed, which might be about the thicknefs of a fhilling, broke in the fire, though the heat was very moderate; it alfo bent and twifted itfelf, in fuch a way as to fhew that it was ftrongly contracted in various directions, and feemed inclined to break and divide itfelf into fmall pieces, fimilar to thofe which were already feparated from it.

This circumftance led me to fufpect, that the afhes upon which I had annealed the plate of gold which had broke in pieces, might contain fome portions of it, and I was not miftaken; for I obtained from thefe afhes, by carefully wafhing them, three or four fmall pieces of the plate, which the live coals with which it was covered had concealed from my fight.

I have already faid, that I referved one of the two pieces of that portion of the ingot which I had

had forged a ſecond time, and that I had kept it in the hardened ſtate in which it came from under the hammer. I could not doubt, after the effect I have juſt related, that by attempting to anneal this piece, before I flattened it, I ſhould meet with the ſame accident I had juſt witneſſed, that is to ſay, that it would break as ſoon as it became red-hot, however careful I might be to expoſe it only to a moderate fire.

I therefore determined to extend it ſtill farther, by paſſing it between the rollers, and to flatten it very gradually, that the fracture, if any ſhould happen, might be owing chiefly to the harſhneſs of the metal, and not to its being made to undergo a violent compreſſion.

By theſe precautions, I contrived, notwithſtanding the harſhneſs of the metal, to extend the piece to double its length, and to reduce it to the thickneſs of ſtiff paper. It is however true, that the ſides of the plate were cracked all along, ſo as very much to reſemble the teeth of a ſaw. But this circumſtance will not be thought ſurpriſing, with reſpect to gold, which, though alloyed only with copper, has not, whatever may be the cauſe thereof, its uſual ductility, particularly when we endeavour to reduce it very thin, without annealing it repeatedly, as the metal grows hard.

It

It might be ſuppoſed, by reflecting upon the experiment I have juſt related, that the breaking of the gold plates perhaps aroſe from the two metals having been imperfectly fuſed, or from their having been unequally mixed; and it appeared to me that, in conſequence of this idea, which might not be ill-founded, it would be proper to melt the ingot again, with all the pieces which were broken from it, and to take particular care that, after being well mixed together, it ſhould be in complete fuſion when poured out. As ſoon as the metal was completely fuſed, I threw a ſmall quantity of calcined borax upon it, that the ſurface might be cleared, and that all foreign matter might be carried to the ſides. The uſe of this quantity of borax, could produce no other effect than a greater degree of ſoftneſs in the metal, and conſequently leſs riſk that it would break, when it ſhould be extended under the hammer.

All the precautions I took in melting this ingot were uſeleſs. When I forged one of the ends, it was, like the former, lengthened very eaſily, without any perceptible crack; but, when this end of the ingot was afterwards reduced very thin, and expoſed to the annealing heat, it broke into ſeveral pieces, the longeſt of which was ſo twiſted, that I have no doubt that it would alſo have

have broke, if the heat had been more ſtrong, or longer continued.

Although the experiment of which I have juſt given the reſult, and in which one part of tin was mixed with twenty-four parts of gold of twenty-two carats, might fairly be conſidered as ſufficient proof that this alloy deprives gold of a great part of its ductility, and expoſes it, in annealing, to an accident which artiſts would hardly be able to avoid, on account of their being obliged to anneal continually the gold upon which they work, in order to reſtore to it that malleability which it has loſt under the hammer; nevertheleſs, however unwilling I might be to deprive the gold of its ductility, which could only be reſtored to it by a freſh parting proceſs, I thought I ought to repeat the experiment with gold of twenty-four carats, and in ſuch quantity that my experiment might be compared with that made by Mr. Alchorne, from which principally he drew his concluſion.

I therefore, in this new experiment, made uſe of ſix ounces of fine gold, and two *gros* of tin. The firſt mentioned metal was divided into a great number of pieces, and I incloſed the two *gros* of tin in two leaves, formed of a part of the ſix ounces of gold, which were ſo thin and ſo flexible, after being annealed, that they completely enveloped the two *gros* of tin. After

putting

putting a part of the gold at the bottom of a ſmall crucible, I placed the tin, wrapped in the gold leaves, upon it; over which I put the remaining part of the gold.

When the whole of the two metals was in complete fuſion, and had been well mixed, I poured the matter haſtily into the ſame ingot-mould I had before uſed; and I obtained an ingot which was a little longer, and cleaner, than the two former ones.

As ſoon as it was cold, I forged one of the ends, with the edge of the hammer. It was lengthened, without any appearance of a crack; and, when it was reduced to about the thickneſs of a line, I cut it off, that I might treat it ſeparately. After moderate annealing, it was ſtill entire; and, excepting a few cracks, it paſſed through the rollers without breaking. But, as I was fearful that it might break, on account of its harſhneſs, if I continued to flatten it, I ſlightly annealed it once more. It had hardly acquired, between the charcoal, the red colour of a cherry, before it broke into five or ſix pieces; ſome of which were ſlightly bent or twiſted; others were quite flat, as they came from the rollers. Amongſt the annealed pieces belonging to that end of the ingot which I was at work upon, there was one rather long, which was only a little twiſted, and which I undertook to laminate afreſh; reſolving

ſolving to reduce it very thin, without annealing it at all. It acquired at leaſt double its firſt length without breaking, and, although the two edges of this plate were cracked, the principal part or body was entire: it was elaſtic, and might have been ſuppoſed to have been formed out of an ingot of common gold, in which no tin was contained, but which did not poſſeſs its uſual ductility.

It reſults from the experiments I have juſt related, that if a ſmall quantity of tin, even of the pureſt kind, is added to gold, whether fine or alloyed, and the two metals are perfectly fuſed together, the gold, in conſequence of this mixture, acquires a certain degree of harſhneſs and rigidity, and loſes ſomewhat of the colour by which it is diſtinguiſhed. It may indeed, by proper management, be extended, to a certain degree, under the hammer, or (which is preferable) between the rollers; but, as it cannot bear annealing, without great riſk of breaking, it loſes, by this defect, the great advantage it otherwiſe poſſeſſes, of being reſtored, after it has been hardened, to its original ſtate of ductility. It is only by means of great care in the uſe of the hammer, and by frequent annealing, that the artiſts who work in gold and ſilver, contrive to finiſh and perfect their works without cracks, or without being obliged to have recourſe to the uſe

of ſolder, to repair thoſe defects which exceſſive hardneſs from hammering would be apt to occaſion. How careful therefore ought goldſmiths and jewellers to be, to prevent tin from being brought into their workſhops, and to avoid uſing any kind of gold which appears liable to break, or even to twiſt, while annealing. The expence of refining ſuch gold, would be an object of leſs conſequence to them, than the additional time which would be conſumed in managing gold adulterated with tin; if indeed they did ultimately ſucceed in working it, and were not forced, after a great deal of trouble, to abandon a piece of work they had nearly finiſhed.

I have no doubt that Mr. Alchorne, if he had extended his experiments, or had conſidered them relatively to the work of goldſmiths, jewellers, &c. who are obliged frequently to paſs through the fire thoſe pieces which they have to work upon and faſhion in various manners, I do not doubt, I ſay, that Mr. Alchorne would then have informed ſuch artiſts, of the accidents to which gold alloyed with tin is liable, during the operation of annealing. He found that this mixture poſſeſſed a ſort of ductility, and did not ſuppoſe it could be taken away by means of fire, which, on the contrary, in general, reſtores to metals their natural ductility, and renders them eaſy to work.

The

The opinion which has hitherto prevailed, re ſpecting the danger which attends the mixture of a ſmall quantity of tin, either with fine or alloyed gold, appears therefore to be very well founded. It would indeed have been very extraordinary, that ſuch an opinion ſhould have been eſtabliſhed without any foundation, when ſo great a number of artiſts have it in their power to aſcertain the truth of ſuch a circumſtance; who cannot help immediately perceiving the harſhneſs of the gold upon which they work, and have every reaſon to induce them to ſearch into the cauſe thereof.

This inſtance, reſpecting an idea generally adopted, and ſupported by conſtant facts, and which moſt artiſts have taken for granted, without much enquiry into the matter, proves that we ought not to attack an eſtabliſhed opinion without great caution; particularly when that opinion, like the one here treated of, is not in itſelf hurtful, and leads only to an exceſs of caution in working the moſt precious of metals.

Mr. Alchorne's experiments have long been recorded in the Philoſophical Tranſactions, and have thereby acquired a degree of authenticity which demands reſpect. My only view in repeating them, and in giving an account of a material fact connected with them, but not mentioned by that ſkilful aſſayer, was to be uſeful to

artifts, and to give certainty to their operations. I truft I have effected this, by leaving them in poffeffion of all thofe fears they have hitherto entertained, refpecting the mixture of tin with any kind of gold.

Suppofing even that my experiments are not fo conclufive as they appear to be at firft, ftill no inconvenience can refult from them, except fome ufelefs trouble to thofe artifts who, relying upon my obfervations, think it right to follow them. However fuperfluous they may feem, artifts will do right to pay attention to them, rather than to work upon fuch gold as, from its harfhnefs, they have reafon to fuppofe alloyed with tin, and confequently incapable to bear annealing.

If it were allowable to form any conjectures, refpecting the caufe of the fracture which takes place in plates of gold alloyed with tin, when they are annealed, it might be prefumed, (as tin quickly enters into fufion; while gold requires a very ftrong heat for that purpofe, and a pretty ftrong one to be thoroughly annealed,) that the parts of the tin, being mixed with thofe of the gold in a fort of proportional equality, tend to feparate from it by a fpeedy fufion, and at a very low degree of heat; that they remain without confiftence among thefe parts of the gold, while thefe latter preferve all their folidity, which they do

do not lose even during the process of annealing. It seems, therefore, that the parts of that precious metal, when brought to a red heat between the charcoal, having no longer the solid connection formed by the tin, and having on the contrary a great number of small cavities, occupied by particles of that metal in a state of fusion, must necessarily have a tendency to disunite; whereas, the same accident does not happen in the pieces which have resisted annealing, and are flattened after being cooled; because the particles of tin have acquired consistence in cooling, and have thereby recovered their former state of union with the gold.

The accident here treated of does not take place in annealing a plate of gold alloyed with copper, for a reason opposite to that I have just pointed out, namely, because these two metals require nearly the same degree of heat for their fusion. Consequently, as the effect of the annealing heat is the same upon the one as upon the other, these metals, during that operation, preserve their usual consistence: indeed, they even preserve it when the annealing heat is carried almost to the point of fusion.

In support of the opinion I have just given, respecting the cause of the breaking of the gold plates, I may observe, that when their surfaces are examined by a microscope, a great number of particles

particles of tin, which appear to be disengaged from the pores of the gold, may be seen; and that, if these plates are annealed lying upon a flat piece of iron, or of silver, they adhere to such piece so strongly, by means of those particles of tin, that they cannot be separated without difficulty; and, in separating, they even bring off some small portions of the metal on which they were laid to be annealed.

I shall conclude these details, into which I have been led by the subject of my experiment, with observing, that the plates of gold here treated of may be kept from breaking, by annealing them on a smooth plate of metal, on which they are to remain till cold; whereas, when placed between burning charcoal, they are subject to twist and break, especially if they are laid hold of with tongs, in order to take them from between the charcoal, while red-hot.

XLIV. *List of Patents for Inventions, &c.*

(Continued from Page 288.)

JOHN DICKSON, of Dockhead, in the county of Surrey, Engineer; for a method of constructing steam engines, pumps, and other hydraulic machines. Dated July 14, 1798.

WILLIAM ROW, of Newcastle-upon-Tyne, Merchant; for a mineral lamp-black. Dated July 14, 1798.

RICHARD MARLOW, of the parish of St. Margaret, Westminster, Carpenter; for a method of hanging a window-sash, and window-shutter, without the appearance of lines and pullies, which are wholly concealed from the sight. Dated July 14, 1798.

WILLIAM DUPE, of Hammersmith, in the county of Middlesex, Gun-maker; for a method of manufacturing bars of a mixture of iron and steel, proper for double-barrel gun-barrels. Dated July 23, 1798.

WILLIAM DOCKER, of Birmingham, in the county of Warwick, Slate Merchant; for a method of making pipes or tubes of a solid block of stone. Dated August 3, 1798.

STEPHEN

Stephen Halladay, of the parish of St. Martin's in the Fields, in the county of Middlesex; for a new invention for the draught or moving of carriages of all descriptions. Dated August 3, 1798.

Philip Chell, Engineer, and Henry Nichols, Builder, both of Birmingham, in the county of Warwick; for a machine for lifting, raising, and conveying boats, vessels, or other things, from an upper to a lower level, or from a lower to an upper level, on canals or rivers, to save water, and prevent tunnelling. Dated August 3, 1798.

John Ashley, of Islington, in the county of Middlesex, Plumber; for a method of raising water from wells, of any depth, upon a very simple and permanent construction. Dated August 7, 1798.

Thomas Staton, of Castle-street, Park, Southwark, in the county of Surrey, Machine-maker; for an apparatus for raising beer, ale, wine, spirits, oils, or any other liquids, from cellars, or other low places, to a higher or more elevated situation. Dated August 7, 1798.

John Cockran, of Paisley, in Scotland, Yarn-Merchant; for a method of spinning flax, hemp, and tow, by means of machinery wrought by water, and which may be wrought by steam-engines, horses, or any other power. Dated August 7, 1798.

REPERTORY

OF

ARTS AND MANUFACTURES.

NUMBER LIV.

XLV. *Specification of the Patent granted to Mr.* JOSEPH BRAMAH, *of Piccadilly, in the County of Middlesex, Engineer; for his Invention of certain new Methods of retaining, clarifying, preserving, and drawing off, all kinds of Liquors commonly used for the Beverage of Mankind, more especially those Liquors called Malt Liquors, such as, Porter, Ale, Beer, &c. together with sundry improved Casks, and Implements, necessary to give his Contrivance the full Effect.*

WITH THREE PLATES.

Dated October 31, 1797.

TO all to whom these presents shall come, &c. Now KNOW YE, that in compliance with the said proviso, I the said Joseph Bramah do hereby de-

clare, that my ſaid invention is deſcribed as follows; that is to ſay, I do not reſt the merits or value of this invention on the preciſe manner of performing the neceſſary parts thereof, or, in other words, on the ſpecific methods herein adopted, for producing the objects of it; for, as invention conſiſts in thoſe efforts of the mind which diſcover new objects, and alſo the beſt means of accompliſhing them, I hereby declare, that I appropriate both, as the baſis of my claim, and that to the full extent of their uſefulneſs, in any and every new application of them I may hereafter diſcover, during the term expreſſed in my patent. This appears to me reaſonable, and the unalienable right of every inventor; for, though the ſubſtance of invention is the birth of new objects, improved methods of obtaining thoſe already known is ſtill invention. Thus, objects and the means by which they are affected being diſtinct parts in every invention, they muſt certainly, according to the law of patents, be both of them the property of an inventor; and, as it ſometimes happens that the objects of inventors prove abortive, while the means contrived to aſcertain them are highly valuable, it is therefore I claim them both, as far as both are new. I ſhall accordingly hereunder, firſt, declare in words, what the true object or objects of this invention are: then ſhew, by drawings and references,

ences, how the ſame is to be performed, in the beſt manner I am, in this unexperienced ſtage of a great undertaking, in judgment able to ſuggeſt; and, in the performance of the work, (ſhould it fall to my lot,) I here aſſure the public, who require this inſtrument as their guarantee, that they ſhall have the advantage of every future improvement I can make, in the means of giving this my invention its full effect. Now the objects of this, my ſaid invention, are briefly as follow.

Firſt. I propoſe to preſerve, and keep from flatneſs and acidity, all kinds of liquors uſed for the beverage of men, during ſuch time as the ſaid liquors ſhall be on tap, or drawing off out of caſks, let the period for this operation be what it may, whether days, months, or years; and thus render unneceſſary the cuſtom of putting liquors in bottles.

Secondly. I propoſe rendering water, and all liquors, perfectly pellucid, and free from heterogeneous matter, by an urged filtration, without the help of iſinglaſs, or other chemical preparation, commonly called finings. The advantages and good effects of ſuch a performance, I need not ſtate to thoſe who are acquainted with the organization of the animal kingdom.

Thirdly. I propoſe, by a ſimple and mechanical proceſs, to convey, and cauſe all kind of li-

quors to flow ſpontaneouſly, through ſmall tubes, from the cellar, into any part of a houſe, above or below ſtairs, at pleaſure. By this means, the cellar-door may be always locked, and thus freed from the injurious circulation of either cold or heat, at all ſeaſons of the year; and, by this means alſo, adulteration, imbezzlement, private drunkenneſs, over-filling, and the various other waſtes in liquors, to which all families are expoſed, will be wholly avoided, and, in public-houſes, &c. infinite labour ſaved. That theſe are ſolid advantages, needs no argument to prove; as the maſter of every family, and publicans eſpecially, can teſtify the great neceſſity there exiſts for reformation in theſe matters.

Fourthly. I propoſe ſecuring and drawing off all liquors, when occaſion may require, by means of cocks conſtructed on a new principle, and made to lock on my patent-plan, ſo as not to be opened by any but thoſe who have permiſſion. This will enable every maſter (if he chuſes) to draw, or witneſs the drawing, mixing, &c. of every drop of liquor he conſumes. This, to publicans, &c. will certainly be a great acquiſition, as the injury done them by careleſs drawing and mixing, &c. is very conſiderable.

Now, I declare, the four above mentioned propoſitions comprehend the principal objects of my invention; and I propoſe the following inſtruments,

ſtruments, as part of the means of accompliſhing them, and on which the merits of the whole jointly depend, *viz.*

Firſt. A caſk on a peculiar conſtruction, with an apparatus to ditto.

Secondly. A pump, with ſundry appurtenances.

Thirdly. A filtering-machine.

Fourthly. A new-conſtructed vent-peg.

Fifthly. Sundry tubes, and a method of making them.

Sixthly. Various cocks, to be uſed in this proceſs, and other hydraulic works, and their principles of conſtruction.

Laſtly. The manner of fixing and organizing the whole apparatus.

Theſe ſeveral points are fully ſhewn, and made appear to every perſon of competent knowledge in theſe arts, by the drawings and references hereunto annexed. I now again declare and affirm, that this inſtrument, whereby I guarantee the reverſionary benefits of this my invention to the public, as a price for the privileges given or intended to be given me, in his Majeſty's grant, does contain a true and unreſerved development of the principal objects of this my ſaid invention, without either over-rating or keeping back any part that has at this moment occurred to my knowledge and underſtanding; and alſo contains

a true

a true defcription of every inftrument, matter, and thing, I purpofe to ufe and apply, in carrying the fame into full effect, both as to individual and collective principle and conftruction. And thefe I declare to be all of the beft kind, and modified for the purpofe in the beft manner I am, in this infant ftate of the undertaking, able to devife, although, doubtlefs, time and experience may fubftitute various fecondary improvements with refpect to form and connection, which I again pledge myfelf to add, as I go along, for public good. But, at the fame time, I muft infift, that what is contained in this fpecification does fully and fufficiently comprehend the true foundation, as well as the neceffary fabric, of this invention, and will be a competent guide to every practitioner, to the moft diftant periods of time.

Having thus candidly and fairly difclofed and exemplified the whole fecret, both of my intentions and the manner of giving them maturity, I moft humbly hope that all courts and juries before whom my cafe may come, will, in their wifdom, and through the love of juftice, protect and guarantee me, in fpite of let or quibble, during the term granted by his Majefty, in the lawful exercife of all the privileges and intereft allowed or meant to be allowed me, by the faid grant, as a reward for fuch labours as merit this diftinction. In witnefs whereof, &c.

The

The drawings hereunto annexed are much more profuſe than is neceſſary to explain the nature and deſign of this invention *; but, in order to ſhew how it may be uſefully applied and extended, I think it proper to inſert them, by way of elucidating the whole, and begin with the plans and ſections collectively.

Within the frame 1 2 3 4 (See Plate XVI.) is comprehended the diſpoſition of the whole ſcheme, in an organized ſtate, extended to various kinds of liquors, and I truſt it is ſo clearly and diſtinctly laid down, that a ſhort explanation will be found ſufficient; and, to be as conciſe as I can, I have put the ſame letters of reference on the plan, ſection, and elevation, of each particular part. A, A, therefore, repreſent the plan and the ſection of a caſk, which I call the drawing-off caſk, repreſented in a vault below the level of the cellar-floor. This caſk may be of wood, or of other proper materials, and of any dimenſions in diameter and altitude, agreeable to the magnitude of the work where adopted. It muſt be made perfectly ſmooth and cylindrical on the inſide,

* In the original drawings, four ſtore-caſks, for different ſorts of liquors, are repreſented. We have omitted two, in our plates, in order to obtain more room; the nature of the invention being as well ſhewn by two caſks as by a greater number.

by

by boring, or otherwise, similar to the cylinder of a steam-engine; and must have a bottom in it, as at B, of sufficient strength to sustain the pressure of a column of liquor, of the same base dimensions, equal to the highest altitude to which the said liquor is meant at any time to be therefrom conveyed. Into the upper end of this cylinder must be fitted the sliding-head or piston C; which head or piston must be as strong at least as the bottom B, and must be made water-tight, all round its circumference, with leather, or other soft materials, similar to the piston of a pump or engine for raising water, &c. To the top of this piston is joined the stem or piston rod D, of a length at least equal to the height of the cask or cylinder A, and stout enough to perform the office hereunder described. On the top of this stem D, is placed a wood box, guided and kept upright by the sliding-frame F F; which frame must be at least as high as will allow the piston C to move the full length of the cylinder A. This box must be of dimensions sufficient to hold as much sand, or other heavy and cheap materials, as will considerably overbalance the column of liquor, as described resting on the bottom B. One of these casks, and its apparatus, must be provided for every kind of liquor meant to be thus preserved and drawn off, and may be placed as shewn in the plan and section A and 5, sup-

posed for malt-liquor, and in the plan 6 and 7, for wines. G G, is a main pipe, passing along below the bottom, and in front of the casks A and 5 for malt-liquor, and 6 and 7 for wines, with lateral branches from it, communicating with each cock. In each of these branches, or in their junction with the main, is placed a cock, for the purpose of opening and shutting, at pleasure, the communication between the said main and each cask, individually, as occasion may require, or, in other words, in order that each cask may be either filled or emptied, through the same pipe or main G G, &c. At the extreme end of this main is a cock I, principally intended for cleansing only. The other end of the main G G, as well as the main HH, is joined to the stop-cock K, which will be described in its proper place. This cock has four branches, as shewn in the plan: the first of which communicates with the malt-liquor casks; the second with the wine casks; the third with the cleansing-cock L; and the fourth, which is the feeding-branch, communicates with the filtering-machine M; which filtering-machine will also be separately described hereunder. Now, by turning the handle of the cock K, the liquors passing through it may be directed, either to the wine, or malt-liquor casks, or to the cleansing-cock L, and, by this means,

any one of the ſaid caſks can be filled at pleaſure. N, N, are the plan and elevation of a pump, made on the common lifting-principle; the ſuction-pipe of which communicates with the ſtop-cock O, which has alſo four branches, ſimilar to the cock K, but is placed the reverſe way; and the feeding-branch in K, becomes the diſcharging-branch in O, which branch joins to, and becomes the ſuction of, the pump N. Two of the other three branches, namely, P P, communicate with the general mains, which lead to the ſtore-caſks 8, 9, for malt-liquor, and 10, 11, for wines, placed in the cellar above, as in the ſection. The mains have lateral branches, and ſtop-cocks, to each ſtore-caſk, exactly the ſame as thoſe deſcribed to the drawing-off caſks, and will occaſionally ſerve for both the purpoſes of filling and emptying them, in a way hereafter deſcribed. The fourth branch of this cock O communicates with a pipe leading to the cock *p*, which is either for the purpoſe of ſtarting or filling the ſtore-caſks, or for cleanſing the whole with water, when neceſſary. There is one branch leads from the cock to the copper R, and another to the well or veſſel S, for holding water; and, by turning the handle of this ſaid cock *p*, the pump will draw from either the copper or the well, and carry the liquor ſo pumped, either into the

the ſtore or drawing-off caſks, as will be ſeen below.

From the upper end of the cylinder of the pump N, proceed two branches or forcing-mains, one of which communicates with the filtering-machine M, and the other with the main leading to the ſtore-caſks; between this main and the pump is fixed a ſtop-cock Q, which will open and ſhut that communication at diſcretion. Now, ſuppoſe the whole of the apparatus, and all the utenſils, to be thus arranged, and the ſtore-caſks of every kind to have been filled in the common way, and ready for drawing off, we will, for example, begin with ſtale porter. Then, let the handle of the cock O, and that of the cock K, be turned to malt-liquor, and the cocks in both the mains GG and P, communicating with the caſks, be opened; then, by working the pump, the liquor in the ſtore-caſk 8 will be forced through the filtering-machine M, into the main GG; and the cock at the bottom of the caſk, ſection A, being open, the liquor will be forced into it by every ſtroke of the pump; and, ſuppoſing the piſton C, by the incumbent weight of the box E, to be deſcended to its loweſt ſtation, as in caſk 5, then, by injecting the liquor under the piſton, it will be raiſed up, (on the principle of my new method of accumulating force,) as faſt as the caſk is

 filled

filled by the pump, until the piſton and loaded box arrive at their higheſt ſtation, as in the ſection-caſk A; and thus the piſton and the weight above will be kept up, and reſt on the liquor, until it is drawn off, when they will deſcend, as the caſk empties. Now, ſuppoſe the tube 12 to be inſerted into the bottom of the caſk A, and carried up to a proper place, appointed for drawing off, as ſhewn by tube 13, in caſk 5; the cock 14 being then opened, the weight of the loaded-box E will, by its balancing the given column of liquor, as above mentioned, preſs down the piſton C, and cauſe the liquor to run out at the cock 14, with a force equal to the ſurplus of the balance, as aforeſaid; and thus, all the liquor of the caſk A will be diſcharged through the cock 14, with an uniform force, only minus the altitude of the caſk; and not a ſingle particle of atmoſpheric air can poſſibly come in contact with the liquor, let the time of this operation be ever ſo long; and thus the acidity, flatneſs, and unavoidable waſte, heretofore common, will be prevented, and the cellar-door may be all the while kept locked. This example, I truſt, is quite ſufficient for all the reſt of the liquors, as the ſame proceſs exactly will attend them. When the liquors in the ſtore-caſks are clear, the filterer may be taken out of the box, as will be ſhewn in the

the deſcription of that article, as it would, in that inſtance, add a trifling unneceſſary labour to the pump.

15 ſhews a ſcale, joined to the top of the loaded box, which may be ſo graduated as to ſhew, by the index 16, the quantity drawn out in any given time, even to a pint, or leſs, if required; and, by this means, the exciſeman can take ſtock with accuracy, in an inſtant, without any inſtrument whatever but his pen; and, by locking up the handle of the pump, and caſing and locking up the index alſo, the liquors uſually taken in caſks will be kept as ſafe from fraud as thoſe taken in the ſtill; and it appears that, by thus ſimplifying the duty of the exciſe-officers, fewer would be wanted; and, by preventing thoſe miſtakes which muſt frequently happen from intricate meaſurements, the general adoption of ſuch a plan would ultimately prove a conſiderable ſaving to the revenue.

By means of theſe cylindrical caſks and loaded piſtons, I mean to convey water, as well as other liquors, in all directions, to the tops of houſes, and elſewhere, for every purpoſe required, without having ciſterns elevated in the uſual way. I alſo intend to apply my method of an urged or forced filtration, in all caſes, for the purpoſe of procuring clear water, for the ſupply of towns,

&c.

&c. as well as for private ufe, and particularly for the ufe of fhips.

Fig. 2. (Plate XVII.) reprefents a fection of the filtering machine, which may be made of copper, tinned on the infide, or any other materials proper for the purpofe. Between the pipes A and B, which form the inlet and the outlet, and through which the liquor paffes, is fixed a filtering-floor C C. This filtering-floor may be compofed of various kinds of materials proper for the purpofe, fuch as, porous ftone, wood, leather, paper, flannel, fponge, fand in bags, or any fuch other materials as time and experience may prove beft adapted to perform the moft perfect filtration. When this filtering-floor is faftened down in its place, and the top of the box D fcrewed down, the machine is ready for ufe: and, when the liquor is forced in at the pipe A, by the pump, as in the general plan, it will be drove through the filtering-floor, and out at the pipe B, which leads to the drawing-off cafk. When the lower part of the box has collected a quantity of dregs, or thick matter, it muft be drawn out at the cock E.

Fig. 3 is the fection of a vent-peg, or, more properly, a ftopper, for the vent neceffary in all cafks, when the liquor is drawn off in the common way. This little machine is conftructed exactly on the principle of an ejex or ftench-trap; and

and has the property of admitting air into, or excluding it from, the caſk, without the attention of the perſon who draws the liquor, and cannot be left in a ſtate not to do its office. A A, is a piece of braſs, with a taper ſcrew at the lower end, to ſcrew into the ſpile-hole of the caſk; the upper end is of larger dimenſions, and turned out in a cup or cylindrical form, with a ſtud or pin riſing up in the middle, as at B; through the centre of this ſtud is perforated a ſmall hole, down through the ſhank or lower end of the peg, ſo as to communicate with the interior part of the caſk at *b*. The cavity which ſurrounds the ſtud being filled with water, the cap or thimble C muſt be inverted and dropped into the rabbet, into which its upper ſurface is fitted, and in which cap muſt be drilled ſome ſmall holes in the flanch, as at 1, 2, in order to admit the air freely; and, by its lower end or mouth being immerſed below the end of the ſtud, nearly to the bottom of the cup, the air will be prevented having ingreſs or egreſs, except when the preſſure of the air is augmented by drawing out the liquor; at which time, the air will force its way into the caſk, through the water contained in the cup, as ſhewn in the drawing.

Fig. 4 is a machine, ſhewing a new method of making tubes of lead, or other ſoft metals, ſuch

as

as tin, pewter, &c. of all dimenſions, and of any given length whatever, without joints. This is performed by a proceſs of pumping or forcing lead, &c. in its liquid ſtate, through metal moulds; by which, tubes, of any given ſhape or ſize, may be made with great expedition, and perfect accuracy. A A, is an iron melting pot, in the centre of which is fixed the pump B, which is made of iron or braſs, with a piſton ſo nicely fitted into it, as to be capable of preventing liquid lead from paſſing it, when preſſed down with conſiderable force: in the bottom of the pump is fixed a ſuction-valve C, made of metal, and ground lead-tight. On the oppoſite ſide of the pump is an arm or pipe, conveyed through the ſide of the melting-pot A A, where the junction is alſo made tight. On the outſide, over the mouth of the aperture of this pipe, is fixed the projecting-tube or mould D; the inſide of which is bored perfectly ſmooth and cylindrical, and its interior diameter is equal to the outſide dimenſion of the tube intended to be made. The end of the mould or tube D, next the pot, and where it is joined thereto, is made conſiderably wider than the mould itſelf, and this part gradually verges to the ſide of the mould. In this wide part, cloſe to the ſide of the pot, is fixed a croſs or bridge, into the centre of which is fixed a mandril, or cylin-

4 drical

drical bar of iron, or ſteel, turned perfectly ſmooth and true, and of a diameter exactly equal to the inſide or bore of the pipe to be made in the mould D; and it muſt be in a ſmall and regular degree diminiſhed in its diameter towards the external end, which end muſt terminate with the end of the mould, or thereabouts. This mandril, ſhewn at E, muſt be ſo fixed into the croſs or bridge, as to be perfectly in the centre of the mould, at the front, as well as at the back end; and there muſt be ſufficient openings in the croſs or bridge, in the wide part of the mould, to allow the lead to communicate, in its liquid ſtate, to the front of the conical part, ſo that it may again unite in a fluid ſtate, after paſſing the croſs or bridge which ſeparates it, and into which the mandril or inſide core is faſtened. The mould D muſt likewiſe croſs the fire-flue of the melting-pot, ſo as to be kept always hot, that the lead which then ſurrounds the mandril or core may be kept in its fluid ſtate, nearly to the external point of the mould. This done, and the pot A A filled with liquid lead, then, by working the pump with a lever of ſufficient power, the lead will be pumped or forced through the mould; and its heat therein being ſo regulated as to chill a little, before it approaches the open air at the point of the mould, it will keep iſſuing out in a

ſolid ſtate; and thus, pipes, of any length and ſize, may be made perfectly ſound, and without a ſingle joint. In order to avoid the nicety of cauſing the lead to chill of its own accord, while paſſing through the mould, it will perhaps be proper to inſert the point, or extreme end of the mould, into the ſide of a ciſtern of *hot* water, or the like.

The next and laſt article to be deſcribed is my improved cocks, to be uſed in this work, and for every other purpoſe where cocks are applied. The peculiar merit of my method of conſtructing and making them is as follows: that is to ſay, I have ſo contrived them, that when the cock is ſhut, the liquor, meant to be retained thereby, ſhall reſt or gravitate, with its whole force, on the upper or larger diameter of the conical key or ſtopper which opens and ſhuts the water-way, in ſuch a manner that the ſaid gravitating force ſhall always preſs the ſaid conical ſtopper or key down to its bearing or ſeat, into which it is fitted by grinding, or otherwiſe; contrary to all cocks made on the old principle, where the gravitating-force of the fluid, always reſting againſt the oblique ſide of the cone, endeavours conſtantly to lift it from its ſeat, and cauſes it to leak. By this means, the cone or key of this cock requires

no

no rivet, or any other contrivance to keep it in its ſeat, but (directly contrary to the old principle) the more it is preſſed upon by the incumbent fluid, the better it fits, and the cloſer it ſhuts; and, inſtead of its getting imperfect by uſe, it will gain perfection; and, from having no rivet, &c. will always move free, and cannot ſet faſt; contrary to thoſe on the common principle, which will, from the neceſſity of their being kept down by a rivet, or otherwiſe, always work ſtiff, or leak.

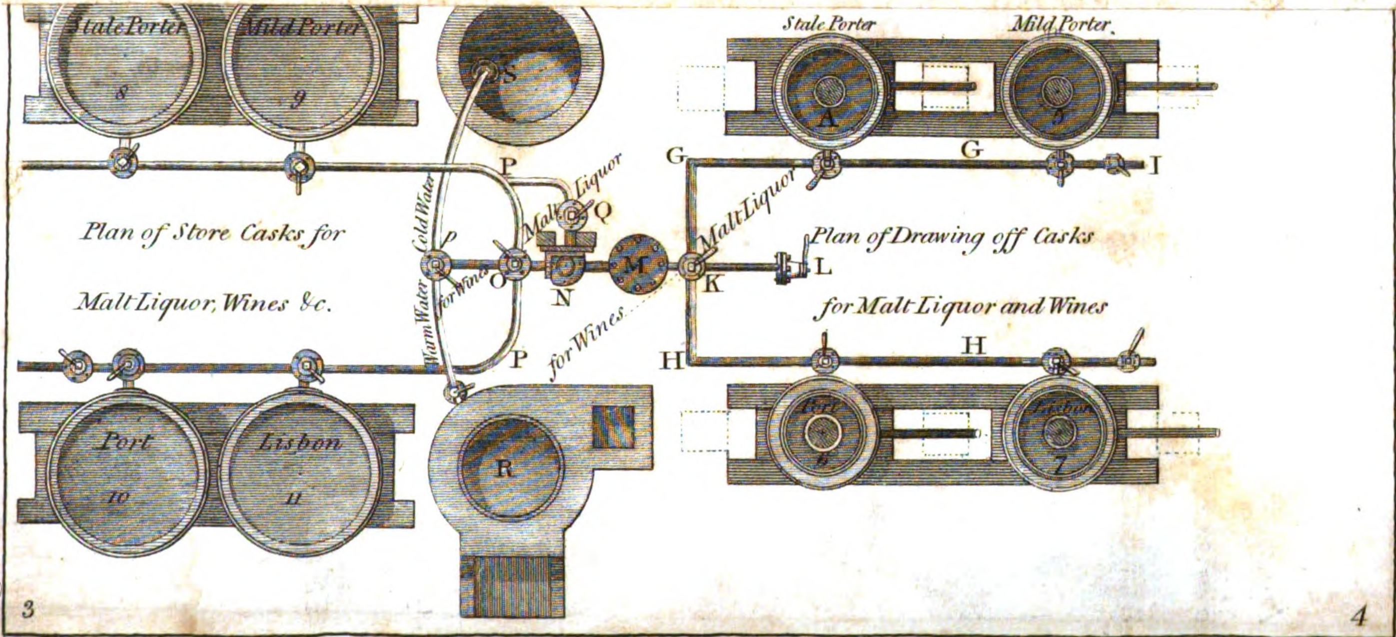
One example will be ſufficient to ſhew plainly how this is to be performed. Figs. 5 and 6 are the plan and ſection of a ſtop-cock. The conical ſtopper A, of this, as well as that of every other kind of cock, is made hollow on the inſide; and the cavity may be of a ſimilar ſhape with the outſide, for the ſake of ſaving metal, or it may be otherwiſe. The top of this interior cavity, or larger end of the cone, may be cut quite open, and left like a cup; or it may be left whole, like a lid, and a hole only perforated through it, ſufficient to let the liquor paſs and fill a ſmall ſpace left between the cone and the cup B; by which means, the liquor will preſs againſt the cup, and re-act on the head of the cone, and force it down. At the lower or leſs end of the cone is the axis or ſpindle C, which paſſes through the

bottom of the external caſe or ſocket of the cock. To this axis or ſpindle is fixed the handle D, by which the cock is opened and ſhut; or, in ſome caſes, it may be opened by the ſpindle E, paſſing through a ſtuffing-box to the handle F. One of the ribs between the water-ways of the cone muſt be cut away, ſo as to leave one rib only, ſo that, when the cock is ſhut, the liquor on the driving ſide may reſt on the cone, to keep it down.

Figs. 7 and 8. (Plate XVIII.) repreſent a cock with ſundry water-ways, where the liquor enters in at the head of the cone; and, by having one aperture only in the ſide of the cone, it may be turned ſo as to diſcharge the liquor at A, B, C, &c.

Figs. 9, 10, and 11, are examples of different ſorts of cocks, and the means of applying them in different brewhouſes.

XLVI.


Stale Porter
Mild Porter
8
9
S
Plan of Store Casks for
Malt Liquor, Wines &c.
Port
Lisbon
10
11
R
P
P
p
O
N
Q
M
Malt Liquor
Cold Water
Warm Water
for Wines
Stale Porter
Mild Porter.
A
5
G
G
I
Malt Liquor
K
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Plan of Drawing off Casks
for Malt Liquor and Wines
H
H
Port
6
Lisbon
7
3
4

Fig. 2.

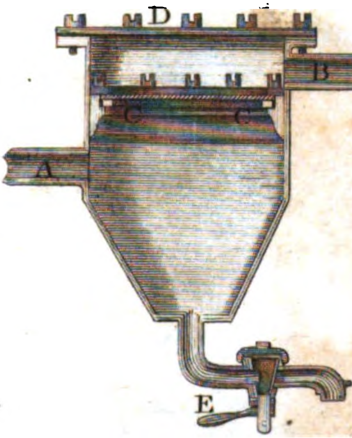


Fig. 3.

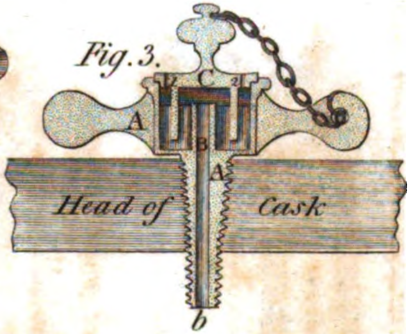


Fig. 5.

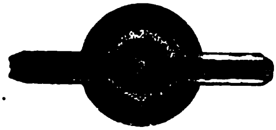


Fig. 4.

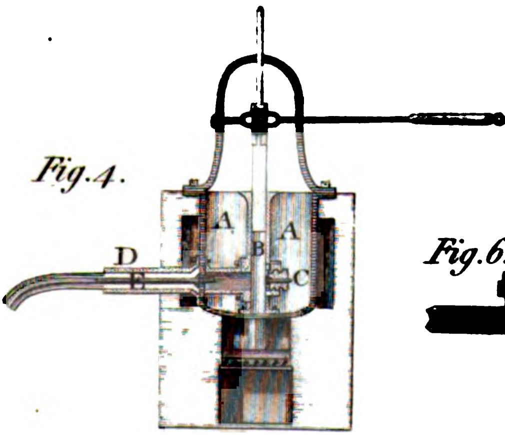


Fig. 6.

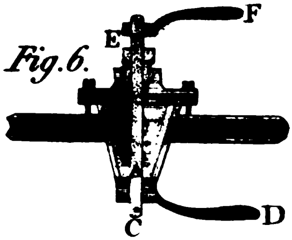


Fig. 7.

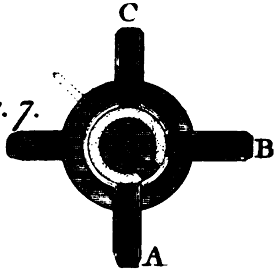


Fig. 8.

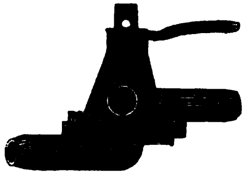


Fig. 9.

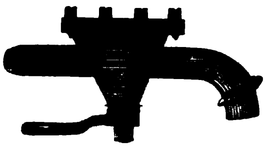


Fig. 10.

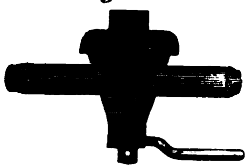
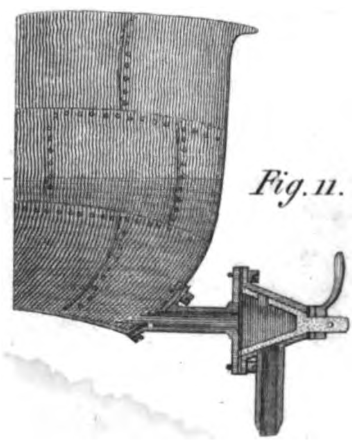


Fig. 11.



XLVI. *Specification of the Patent granted to* ABRAHAM BOSQUET, *of Stangate, in the Parish of Lambeth, in the County of Surry, Esquire, formerly of Sandymount, in the County of Dublin, and late one of his Majesty's Commissaries of the Musters; for a Method, by the Application of which, his Majesty's Navy, and all trading Vessels, may derive Durability, Soundness, Staunchness, and many other Advantages.*

Dated June 8, 1798.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Abraham Bosquet do hereby declare, that the nature of my said invention, and the manner in which the same is to be performed, is particularly described and ascertained in the schedule or particular hereunder written. In witness whereof, &c.

The Schedule above referred to.

A measure for effectually avoiding the intolerable nuisance and destructive effects of rats on board

board ſhips, and for the prevention of leakage, or making bilge water, and alſo for the better preſervation of his Majeſty's ſhips, and all trading veſſels, from decay.

The above evils and inconveniences have long exiſted, and are attended with the moſt deſtructive conſequences to ſhips, their proviſions, and merchandizes, and the health of ſeamen; the following ſimple and ſalutary meaſure is not attended with any comparatively material expence, and will, I truſt, appear at firſt view to be adequate, in the fulleſt extent, to the deſired end. The rapid decay of ſhips, and their perpetual repairs, are attended with an enormous expence, both to the nation and individuals, and claim the moſt ſerious attention, particularly as the oak of this country, which is the beſt of all other, cannot much longer ſupply the increaſing occaſion for it. The waſte in proviſions, and other deſtructive effects occaſioned by rats on board ſhips, are of inconceivable magnitude, and for theſe no remedy has heretofore occurred. The perpetual danger and labour attendant upon leakage in ſhips, cannot be prevented by caulking, or any other precaution hitherto uſed, though frequently the loſs of the ſhip is the conſequence, and much injury to the cargo always enſues; nor is the foul, damp, and ſtagnated air in ſhips, unworthy every conſideration which can afford redreſs.

dreſs. To apply at once a ſovereign remedy to all theſe evils, unattended with a ſingle inconvenience, the mode I have adopted is, the occupying or filling up the void ſpaces between the planks, lining, and timbers of the ſhip, to which the planks are bound, with hot or melted pitch, tempered, as far as found neceſſary, with a due, yet ſmall, proportion of tar, common glue, bees-wax, and tragacanth, to render the pitch leſs brittle, more tenacious and durable. Theſe being blended together in the kettle, there is to be mixed therewith a certain portion of cork-ſhavings, and ſmall bits of waſte cork-wood; but, in caſe enough of theſe cannot be procured, cut ſtraw, bullruſhes, flocks, old junk, and the like, may be ſubſtituted. But, in thoſe parts where the timbers are remote from each other, pieces of cork-wood, or ſlips of deal, may be introduced; which will render leſs pitch, &c. neceſſary in thoſe ſpaces, and at the ſame time diminiſh its weight.

The manner of applying the compoſition is ſimple and expeditious, and is as follows: The ſhip being on the ſtocks, and ready for the laying and application of her floor and lining, the floor being firſt laid, and a few planks of the lining well jointed, laid on, and bound to, the timbers, to the height of about three feet all round, the compoſition is to be poured in, between the timbers, planks, and lining, as hot as poſſible;

poſſible: this, by its weight and fluidity, will introduce itſelf under the floor, from either ſide to the keel, inſinuating and ſaturating every ſpace and crevice, however minute. Thus much being done, four or five feet more of the lining may be put up, all round, and the compoſition poured in as before; and ſo on, till all is complete to the neceſſary height. Ships already built may be ſaturated with very little additional trouble or expence: the ſhip being brought into a dry dock, and a little of her floor taken up, that ſhe may dry thoroughly, the floor being again laid down, a plank of the lining, all round, at two or three feet above the level of the floor, is to be ripped off, and the compoſition poured in, as before mentioned. The planks being replaced, another plank, five or ſix feet higher, all round, to be removed, and ſo to proceed, till all is finiſhed. This meaſure will effectually prevent rats from finding an habitation on board ſhips, as thoſe ſpaces between the timbers are their ſtrong holds, where they cannot be come at or annoyed, and where they carry their plunder, breed, die, and rot; the bad effects of which are too often ſenſibly felt. To pitch and tragacanth, rats have an averſion, and never touch the one, or approach the other, in any manner, if they can avoid it. How far theſe ſpaces being ſo filled up, might ſtiffen the ſhip, I know not; but I think that the in-

terior parts, in which the nails, pins, bolts, and trunnels, are inſerted, as well as thoſe themſelves, being much longer preſerved from decay, muſt not only preſerve their ſtrength and ſoundneſs, but retain their hold, and remain firm and unſhaken in the timbers, to a much greater extent of time, and of courſe the ſhip maintain her ſtiffneſs, in conſequence thereof; but, to a certainty, it will have the important effect of wholly preventing bilge water, and ſmall leaks, which reſult from ſtraining, want of caulking, &c. &c. and perhaps render caulking altogether unneceſſary. This compoſition will have the effect of ſo much ballaſt, in the beſt poſition in which ballaſt could be placed, as it will nearly occupy the centre of motion; and, in caſe of the ſhip filling by any accident, would operate as a buoyant body in the ſhip, and occupy the receptacle of ſeveral tons of water, which would otherwiſe find place between the timbers. This meaſure will moſt eſſentially conduce to keep ſhips ſweet and dry, and effectually preſerve the planks, timbers, &c. from that rapid decay to which they are at preſent ſubject by the injurious effects of the water, which is at all times diſpoſed to inſinuate itſelf; rotting the pins, iron bolts, trunnels, &c. ouzing through the lining, to the injury of the cargo in contact therewith; leaving a damp and ſlimy matter behind, and rendering

the air in thoſe ſpaces, already foul, of the moſt noxious quality, and which no ventilation can, even for the moment, ſufficiently purify. It will alſo, I believe, be obvious that foundering can rarely happen to ſhips ſo fortified; not only becauſe their ſides will be nearly as ſtaunch as if there was not a joint or ſeam throughout; but, even in caſe of a bad leak, at any time, finding its way into the ſhip, it would be at once diſcovered, and it could not dripple down between the planks and lining, and of courſe would ſhew itſelf at the part admitting the water; but I am of opinion that ſhips, in general, would not make a quart of water where they at preſent make a ton. This compoſition being light, firm, elaſtic, and adheſive, and ſtill rendered more light and tenacious by the admixture above mentioned, will comply with the planks, timbers, &c. in all diſpoſitions to warp or ſtrain, and thereby prevent the ſhip making water at her ſeams, when ſhe might otherwiſe fill.

XLVII.

XLVII. *Specification of a Patent granted to Mr.* CHARLES FEARNE, *of the Inner Temple, London, and Mr.* JAMES GRAY, *of St. Margaret's, Westminster, Gentlemen; for a Method of dying Paper, Card-paper, and White Leather on the Grain Side, of various Colours.*

Dated January 25, 1770.—Term expired.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, we the said Charles Fearne and James Gray do hereby declare, that our said invention of a method of dying paper, card-paper, and white leather on the grain side, of various colours, different in quality, and superior in many respects, to any hitherto used for those purposes, is described in the manner following: that is to say, the colours for leathers are these following; to wit, red, blue, green, black, with various shades of each. The reds are various, and are produced by a tincture of carmine, by a tincture of cochineal and madder, or a tincture of

 cochineal

cochineal heightened by a ſolution of tin; or, laſtly, from decoction of brazil and alum, in malt liquor. Blue is produced from a ſolution of indigo in oil of vitriol. The green is an admixture of the blue with any yellow tincture, at pleaſure. Blacks are produced from the blue added to a tincture of galls, ſumach, and Campeachy-wood, ſtricken black by tincture of ſteel, or ſal martis. The colours for papers are all the above-mentioned, prepared in the ſame manner, together with yellow, purple, orange, brown, and their ſeveral intermediate degrees of variation. Yellow is produced by a tincture of French berries with ſaffron, as alſo by moſt of the yellow dies now commonly uſed for thoſe purpoſes. Orange is produced by the admixture of the yellow with madder. Purples are produced by the admixture of logwood with the blue tincture; or from cochineal, with ſal martis, or tincture of ſteel. Browns are obtained from Arnotto and Japan earth, with galls and ſal martis.

With reſpect to leathers, the method of application is, to dip them on the grain ſide, ſo long and ſo often as may be found requiſite for the depth of colour deſired. This is to be done in a flat pan or veſſel, capable of receiving the leather extended therein, with its grain ſide on the liquor. When dry, they are to be waſhed with a ſpunge,

a ſpunge, and ſoap and water, and finiſhed by rubbing with dry flannel, except the blacks, which are to be oiled before they are waſhed.

With reſpect to papers, they are to be procured from the mills unſized; and, in that ſtate, tenderly paſſed through the colouring-liquor, mixed with ſuch a portion of ſize as the intended degree of ſtiffneſs may require; which may be done, either by the hand, or by a contrivance ſimilar to that uſed in the paper-mills for ſizing their paper; and this is to be continued till the paper ſhall have acquired the intended depth of colour. After which, it is to be hung up on fine horſe-hair lines, or on glaſs tubes; and, when the colour ſhall have become what the dyers call ſet, then it is to be paſſed through cold water, and be hung up to dry; after which, it is to be preſſed and poliſhed, according to the uſe for which it may be intended. In the above applications, the tinctures are to be uſed hot or cold, as may beſt ſuit the depth of colour required. In witneſs whereof, &c.

XLVIII.

XLVIII. *Specification of the Patent granted to Mr.* WILLIAM FINCH, *of Woombourne, in the County of Stafford, Iron-master; for certain new Methods of making Nails and Spikes, of Iron, Copper, and other Metals, by means of certain Machinery put in Motion by the Force of Animals, Water, Wind, or Steam, instead of making them by Hand.*

Dated July 28, 1790.

TO all to whom these presents shall come, &c. NOW KNOW YE, that my machinery for working the hammers, by which all manual labour will be saved, consists of one main shaft, caused to turn round, in either a horizontal or perpendicular direction, by means of a water-wheel, or the effects of fire by a steam-engine. Such main or principal shaft will put in motion, by means of cogg and round or tooth and pinion wheels, other counter shafts or barrels, whereon are fixed coggs, tappets, or arms; which coggs, tappets, or arms, striking upon the helves or shafts whereon the hammers are fixed, work the same in either a lift or tilt manner. Also, to make three divisions of hands in the manufacturing of headed nails; namely, one man, woman, or child, to carry the heated rod to the man, woman, or child, stationed before the hammer; which man, woman, or child, by mere activity, will, with one hand, not only form the largest sized nail, but a far greater

greater number in the ſame given time; when the third man, woman, or child, will, with the ſame kind of hammer, head and finiſh a number of the ſaid ſhanks together, leaving them truer made, and better for uſe, than the preſent mode. Alſo, by a diviſion of hands, will make ſuch nails as require no tool or frame to be headed in; namely, the one, as heretofore mentioned, to carry the iron from the fire; and the other, as ſtationed before the hammer, to finiſh them. Alſo, by heating many rods in one fire, there will be a ſaving of coal. Alſo, by the more ſpeedy motion of machine-hammers, ſeveral nails will be made at once heating of the rod; whereas, by the old method, only one is made, conſequently, there will be a great ſaving of yeild. Alſo, the motion being regular, independent of ſtrength, a child will be able to make the largeſt nail or ſpike. And a farther and conſiderable benefit will ariſe to the manufacturer by this mode; namely, that he will have his buſineſs done at one place, or under one roof; whereas, by the old method, the workmen live many miles aſunder, and cannot be overlooked. Likewiſe, by this method, the limbs of thoſe employed in the manufactory will be preſerved to the end of life; whereas, in the old method of working, men are frequently lamed in ſeven or ten years, and obliged to be maintained by the pariſh. In witneſs whereof, &c.

XLIX.

XLIX. *On the Cause of the Smut in Wheat. By Mr.* Joseph Wimpey, *of North Bockhampton.*

From the Letters and Papers of the Bath and West-of-England Society for the Encouragement of Agriculture, &c.

In a former paper on this very difficult subject*, I observed, that it was no unusual thing to meet with ears both of smutty and sound corn issuing from the same root. Also, that it frequently happened, that smutty and sound grains were to be found in the same ear; and that I had then by me the corn I had picked out of such an ear. It contained forty smut balls; 21 grains that appeared to be perfectly sound; and five grains which had one end black and smutty, and the other sound. These I made the subject of experiment, the result of which was as follows.

On the 2d of September, 1789, I put the twenty-one grains above mentioned into a two-

* The paper here referred to is printed in our seventh volume, page 405.

ounce phial of pump-water, which I very well fhook together. It was then fet by till the next day, when the water was poured off, and the corn divided into two parcels. Having filled a two-quart garden-pot with common mould, ten of the grains were fet in five holes, about two inches deep. The other eleven grains were returned into the phial, it being firft nearly filled with a ftrong pickle of falt and water. After ftanding 24 hours, thefe were alfo fet in a garden-pot, in all refpects fimilar to the other. My intention in thefe different proceffes was to difcover, 1ft, if corn from a fmutty ear, merely by rincing in fimple water, would produce found corn, free of fmut; and, 2dly, if a ftrong folution of falt and water would more effectually anfwer that defirable purpofe, as was generally believed, and infifted on.

The beginning of December, I obferved the plants feemed much crouded, and wanted more fuftenance than the fmall quantity of earth the pots contained could fupply. On the 8th day, therefore, I took them out of the pots, and planted them in a row in the field, about eight inches apart, keeping, however, the plants of each pot feparate. There was no perceivable difference in the plants; in both pots they had fhot vigoroufly, and it was truly amazing to fee the immenfe quantity of roots the pots contained;

the ſides being completely lined, with the ſame running round and round, to an incredible length; from whence it ſeems very probable, that the roots of wheat, in good land, well pulverized, may extend, and collect ſuſtenance, at ſome feet diſtance from the parent ſeed.

At this ſeaſon, vegetation is nearly at a ſtand. It was the end of March, or beginning of April, before the plants began to ſhew the leaſt appearance of recovery from the check occaſioned by tranſplanting: however, they then began to ſhoot vigorouſly, and at length acquired an uncommon degree of ſtrength, length, ſize of ear, and plumpneſs of grain, having from 12 to 24 offsets or ſtalks from each plant. I reckon I am much within compaſs, in ſuppoſing that the produce of theſe 21 grains was not leſs than 15,000, and the grain as plump and fine as ever I ſaw, and every corn perfectly free from ſmut. It would be ridiculous to ſuppoſe, that this corn was in any reſpect better than it would have been from ſound and perfect ſeed: its extraordinary vigour I impute ſolely to its being tranſplanted into freſh ground, well pulverized; which could not fail to give much additional ſuſtenance and ſtrength to the plants, and would probably afford the greateſt produce poſſible, on any given quantity of land. But I am ſenſible it could never anſwer the extra expence, nor be at all practicable, on a

large

large ſcale, notwithſtanding ſome mere ſpeculative men have wildly imagined the contrary.

From this account, it is as certain as experiment can make it, that a ſmutty crop of wheat is not the neceſſary reſult of ſowing ſeed from corn that is ſmutty; alſo, that it does not owe its corruption to any vicious principle or defect in the ſeed. In this experiment, we ſee the ſeed rinſed or ſoaked in ſimple water, produced as clean and perfect grain as that which was ſoaked in a ſtrong ſolution of ſalt and water; and therefore were not in the leaſt tainted by the ſmutty grains in the ſame ear, nor at all affected by the cauſe, whatever it was, that vitiated them; or, if they were, that the ſoaking and rinſing in ſimple water was as effectual to the preſervation of the crop from ſmut, as the ſtrong pickle. But it is a truth univerſally known from experience, that in unfavourable years, corn is generally ſmutty, notwithſtanding brining, liming, and every precaution hitherto uſed to prevent it. From all which it clearly appears, that the general cauſe of the ſmut does not exiſt in the ſeed, but is owing, if not altogether, yet in a very great degree, to ſome vitiating principle in the air, a conſtant concomitant of cold, wet, ſtormy, tempeſtuous ſummers, which are ever attended by ſmutty crops. My reaſon for ſuppoſing the ſmut may ſometimes poſſibly be derived from the ſeed, will appear hereafter.

In the above experiment, one thing occurred which I must not omit, for it well deserves to be noticed. One part of the seed was soaked in clear water only, the other in a strong solution of salt and water. I could perceive no difference in the plants, on a comparative view, from the time of their first coming up to the maturity of their growth, except in their tillering. The plants in both experiments were equally vigorous, equally tall and strong, the ears equally long, large, and full, and the grains equally plump and heavy; but those steeped in the brine tillered out considerably more, that is, put out many more stalks, than those steeped in water only; consequently, were much more productive. What the superior fructification was owing to, is well worth enquiry. The seed was out of the same ear; and, though set in two different spots, it was in the same earth, and transplanted into the same ground; the culture in every respect the same; the only difference was, in one the seed was steeped in clear water 24 hours, and then planted; in the other, after being steeped 24 hours in the same water, it was steeped 24 hours more in salt and water. The question is then, and a very interesting one it is, whether the superior fecundity of the latter was owing to the seed being steeped twice as long as the other, or to its being impregnated with the salt used in the solution, or

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to some secret cause not discovered, and possibly not capable of being discovered, by the experimentor.

By repeating and varying these experiments, it would be easy to discover, whether fertility is promotable ov steeping a longer or a less time in water; and, 2dly, if water in which a good quantity of salt has been dissolved, does not encourage and promote vegetation more than simple water. If it should be found to do so in any considerable degree, I cannot have a doubt but a strong lixivium, made of wood ashes, would promote it much more. I have always been of opinion, that such menstruums were useless, or at most, that their aids extended no farther than the first rudiments of plants; but the fact recited above strongly inclines me to repeat the experiment, in order, if possible, to fully ascertain the facts.

In the next place, I shall give an account of an experiment made with the five grains mentioned above, which were smutty at one end, and sound at the other. These were set in a small garden-pot, like the former, one of which only came up. In the spring it seemed to want more room; I therefore dug a hole in the ground, and, taking the mould out whole from the pot, it was planted in the same, without disturbing the roots. It soon grew vigorously, but never had the

the healthy and robuſt appearance of the others. It had always a ſickly greeniſh yellow look, which betrayed its malady, notwithſtanding its ſtems grew to a good height, and tillered ſurpriſingly. I counted 24 ears from this ſingle grain, moſt of them of a good length, but lank and thin, very unlike the appearance of thoſe ſmutty ears which are not affected till the blowing ſeaſon; for theſe very often are the fineſt and plumpeſt ears in the field, till that time.

Of theſe 24 ears, 23 were entirely ſmutty, not a ſound corn could be found among them. The other was quite a ſmall underling ear, which did not appear till a full month after the others, but always bore a healthy appearance. This ear produced 14 corns only, and thoſe ſmall and thin, but ſound and perfect. Theſe were planted again laſt Auguſt, and are now as fine and promiſing as any corn in the field.

From this experiment it ſeems to appear, that a grain which is vitiated with the ſmut, yet has enough of the vegetative principle ſound to enable it to grow, infallibly produces ſmutty grain. That one ear, and one only, out of 24, ſhould be ſound, is indeed very ſtrange; but perhaps not more ſo than that, in the animal creation, the offspring of a diſtempered ſire may in general be affected by the vitiated ſtamina of the ſire, yet ſome one

or

or more efcape the hereditary taint, and appear perfectly found.

From thefe, and the experiments of the former paper, the following corollaries are clearly deducible:

First. That found grains from very fmutty ears, produce as clean and as found crops as feed from corn that is perfectly free from fmut.

Secondly. That feed from the foundeft and cleaneft crops doth frequently, in wet, cold, unfavourable feafons, produce fmutty crops, in fpite of fteeping, brining, liming, change of feed, and every device and invention which the wit of man hath ever practifed.

Thirdly. That in fine, dry, warm fummers, it frequently happens there is little or no fmut at all; and that, in many inftances, where fmutty feed has been fown, the produce has been clean, and perfectly free from the fmut.

Fourthly. That the fmut is not an hereditary difeafe, proceeding from a corrupt or vitiated ftamina in the feed; but ufually and almoft entirely occafioned by fome blight or vitiating principle in the atmofphere, which corrupts or deftroys the vivifying principle, at the time of its blowing and fecundation.

Fifthly. If the fmut ever proceeds from diftempered feed, it can be only from fuch as hath

the germ or feminal principle found and entire; for mere fmut balls are as incapable of vegetation as powder of poft, or the moft effete matter in nature; but this is a cafe fo rare, as not to be adequate to the production of a millionth part of the fmut that happens; therefore, it muft generally proceed from fome malignant principle, which at fome feafons fubfifts in the air.

Sixthly, and laftly. If the caufe of the fmut does not fubfift in fome latent or occult corrupt principle in the feed, but is generally occafioned by the intemperance of the air, fix or eight months after the feed is fown, it feems perfectly nugatory to ufe any means to remedy or prevent a diforder which has no exiftence, even in its caufe, and moft probably may never happen; unlefs it could be made appear, that thofe means beftowed fuch a degree of ftrength and vigour to the plants, as might render them lefs fufceptible of any malignant impreffion from the atmofphere, which might happen to reign during any future ftage of their growth.

I have now feveral more experiments in profecution, having fet many fmall quantities of found grain, picked from fmutty ears at different times. At prefent they all appear very promifing; but the refult cannot be known till the next harveft, when, if found interefting, I may probably requeft leave to lay it before the fociety.

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L. *Deſcription of a quick and eaſy Method of converting Weeds, and other vegetable Matter, into Manure. By Mr.* H. BROWNE, *Chemiſt, of Derby.*

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

ACCORDING to a promiſe I made ſome years ſince, I beg leave to communicate to the Society for the Encouragement of Arts, &c. and (if thought worth notice) by them to the world, a compoſition for manure. Fearful it would not anſwer the purpoſe ſo fully as I could wiſh, I deferred it from year to year; but I now find, by numerous trials, made by my friends as well as by myſelf, the very great utility of the compoſition, as well as its cheapneſs, with the capability of its being made in any ſituation, and in any quantity. The mode of making it is as ſimple, as I truſt it will be found productive. It is nothing more than

green vegetable matter, decomposed by quick or fresh-burnt lime. Upon a layer of vegetable matter, about a foot thick, a very thin layer of lime, beat small, is to be laid; and so on, vegetable matter, then lime, alternately. After they have been put together a few hours, the decomposition will begin to take place; and, unless prevented, either by a few sods, or a fork-full of the vegetables at hand, the mixture will break out into a blaze, which must at all events be prevented. In about twenty-four hours, the process will be complete, and you will have a quantity of ashes ready to lay on your land, at any time you wish. Any and all sorts of vegetables, and weeds of every description, if used green, will answer the purpose. They will doubly serve the farmer, as they will not only be got at a small expence, but will in time render his farm more valuable, by its being deprived of all noisome weeds.

But, if this composition answers the purpose, as I flatter myself it will, a very short time will see almost every weed destroyed. Supposing that to be the case, I have made a calculation with clover, grown for the purpose; for instance, I will take one acre of clover, which at one cutting will produce from fourteen to eighteen tons of green vegetable matter, and will require about three tons of lime; this, when decomposed by the

the above procefs, will yield afhes fufficient to manure four acres, the value of which I eftimate at fomething under four pounds. The clover, according to the value of land here, at two pounds, which, taking the average of the kingdom, is too much: the lime alfo at two pounds; but that will vary, according to the diftance from which it is to be fetched: take them together, I think the above will be about the average value. Now, if this is the cafe, and, as far as I have been able to try it, I find it fo, how valuable muft this method be to the community in general! If it anfwers the purpofe, I fhall feel myfelf much obliged by the Society making it as public as they poffibly can.

The vegetables fhould be ufed as foon after they are cut as poffible, and the lime as frefh from the kiln as the diftance will allow of; as on thofe two circumftances depends the goodnefs of the compofition.

LI. *Farther Observations on the Process for converting Cast into Malleable Iron.* *By* Thomas Beddoes, *M. D.* *

From the Philosophical Transactions of the Royal Society of London.

Since I described the process known among the workmen by the term *puddling* of iron, I have several times reconsidered the explanation I there attempted, of the phænomena it presents. My explanation could not indeed but be in great measure conjectural; and subsequent reflection excited in my mind a very lively wish to ascertain, in a decisive manner, the nature of the process. The following experiments will, I flatter myself, serve to determine the degree of confidence with which the principal points of my theory may be received, though they will not afford a solution of all the questions which my former observations might suggest to an acute philosopher.

* Dr. Beddoes's first paper on this subject is inserted in our eighth volume, page 282.

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They were undertaken in order to ascertain, first, whether any elastic fluids are really extricated during the conversion of cast into malleable iron; secondly, what is their nature; and, thirdly, whether they vary at different periods of the process, as I concluded, from the appearances in the furnace. It seemed of less consequence to ascertain their quantity: I did not, however, neglect this object of inquiry, but some very curious circumstances prevented me from attaining it.

Experiment I. Six pounds of dark grey melting cast-iron were put into an earthen retort; a glass tube was luted to the neck, and its extremity was immersed in water: the retort was placed in a wind-furnace. Before the retort and its contents could be supposed to be red-hot, inflammable air came over. It burned with a deep blue flame, and was in no degree explosive. It rendered lime-water turbid, and was partly absorbed. When the retort had been heated about an hour and a half, the air, which was coming over pretty copiously, (that is, at the rate of an ounce-measure every three minutes, upon an average,) suddenly ceased, and the apparatus, on examination, proved to be no longer air-tight. The retort was found to be cracked; the lumps of iron had none of them

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been melted, but they had been foftened, and conglutinated together.

Experiment II. Four ounces, Troy, of the fame iron were put into one of Mr. Wedgwood's earthen tubes, glazed, and clofed at one end. That end of the tube was inclofed in a barrel-fhaped crucible; the interftice filled with fand, and the crucible reclined, fo as to form a very fmall angle with the horizon: in other refpects, the apparatus was difpofed as before. On the application of heat, air was again extricated, fooner than I fhould have expected, of the fame inexplofive inflammable kind. About one-feventh of that which came over firft, and which traverfed the water of the receiving-veffels, was abforbed by milk of lime. The refidue burned flowly, with a flame apparently not fo deep as before the carbonic acid was feparated.

In this and the former experiment, the elaftic fluids were moft rapidly extricated on the firft impreffion of a red or white heat; afterwards they came over much more flowly: during a confiderable part of this experiment, you might count twelve, flowly, between every air-bubble.

When the utmoft power of the furnace had been exerted for three hours, a phænomenon occurred which produced fome furprife in every perfon prefent; and there were feveral who had been

been abundantly accuſtomed both to chemical and metallurgical operations. A conſiderable abſorption took place, and, for about half an hour, it was neceſſary to blow air up the glaſs-tube, to prevent the water from riſing into contact with the iron. It afterwards appeared, that the lead of the glazing was revived, which ſufficiently explains the abſorption.

586 grains only of the iron had been completely fuſed. The ſurface of two of the unmelted lumps was curiouſly covered with numerous ſmall bliſters of metallic lead.

About ſeven hours after the fire was firſt kindled, it was diſcovered that the apparatus had failed. I had examined the air that came over, immediately before this accident, both by means of lime-water and milk of lime, without diſcovering any veſtige of carbonic air.

The iron weighed altogether three grains more than at firſt. But the adhering lead, and a quantity of lead alſo which was incorporated with the iron, concealed a real and probably a conſiderable loſs of weight. The phænomena it exhibited, when put into weak vitriolic acid, and the vitriolated lead which was formed, indicated the preſence of this metal in all the ſuperficial parts of the maſs. When it had been kept ſome time in vinegar, it diſſolved readily enough in vitriolic acid,

acid, at firſt, but the ſolution ſoon ceaſed, or became very ſlow.

Experiment III. A coated flint-glaſs retort was employed in this inſtance. The apparatus reſiſted a ſtrong heat for two hours; and air, of the heavy inflammable kind, came conſtantly over.

Experiment IV. A coated retort of crown-glaſs, containing ſix ounces, Troy, of the ſame iron, was placed on a crucible nearly full of ſand, and diſpoſed as in the former experiments. I now wiſhed to meaſure the quantity of the air, and I therefore determined to receive it in mercury: it would have been in vain to attempt this in water, on account of the carbonic acid air. About twelve o'clock, the retort was judged to be of a dull red heat, and inflammable air came over. The orifice of the tranſmitting glaſs tube was now covered to the depth of half an inch with mercury, when the diſcharge of air inſtantly ceaſed; the lute ſeemed entire. Some of the mercury being removed, ſo as to leave juſt enough to cover the mouth of the tube, the air immediately iſſued again in bubbles; a proof that the apparatus was entire. The mercury was again poured into the trough, and in an inſtant there was a ceſſation of air. The mouth of the tube being uncovered, and a lighted paper applied, a blue flame appeared, and continued to burn, ſo great was the quantity of air

diſcharged;

discharged: the orifice of the tube was one-tenth of an inch in diameter. We found that this constant flame could be produced at any time, during three hours and a half. When water was substituted in place of mercury, air issued slowly, and as if with difficulty, under a pressure of five inches. When only half an inch was left over the mouth of the tube, small bubbles ascended freely: during a considerable time, I counted four, slowly, between each of these bubbles. I did not collect above three ounce-measures of air, and this contained carbonic acid. It was past four o'clock when the apparatus ceased to be air-tight, and the fire had been kept as strong as possible. The iron was most completely fused. There was a good deal of revived lead within the retort; there were also many globules in the neck. Probably some broken flint-glass had been added to the usual materials for crown-glass; I cannot otherwise account for the appearance of the lead here. In the last experiment, the lead of the flint-glass had been revived.

Experiment V. Two ounces of the same iron, immediately upon being taken out of a retort, in which they had been kept at a red heat for about an hour and a half, and which were, therefore, as free from water as iron can easily be procured, were put into an earthen tube, unglazed, and closed at one end. This tube was

difpofed as in Experiment II, only the end of the glafs tube was immerfed in mercury, inftead of water. It is not furprifing that air did not now come over fo foon as in any former inftance. When the fire was raifed to its full force, exactly the fame amufing variety of appearances took place as in the laft experiment. Under the preffure of half an inch of mercury, not a particle of air was difcharged; but, the moment the preffure was diminifhed to a fmall fraction of an inch, the bubbles fucceeded each other pretty quickly; and fo on repeatedly. Upon lowering the furface of the mercury, and pouring fome water upon it, I received more than two ounce-meafures of air, which, by the teft of lime-water, did feem to contain a veftige of carbonic acid, but it was too minute to be appreciated. This experiment with the air, was made after a ftrong white heat had been kept up for three hours. Soon afterwards the bubbles ceafed; but we could not then, nor upon examination of the apparatus when cold, difcover any failure. The fire was ftill kept up for three hours: the tube muft have been expofed to a ftrong white heat feven hours in all. The iron had loft eleven grains in weight: only about one half had been thoroughly fufed. The furface of two lumps, that had not been fufed, had the clofe texture, and filvery appearance, of malleable iron.

iron. The thin edges yielded to the ſtroke of the hammer, and a gentleman perfectly converſant in the nature of iron, agreed with me, that it had all the characters of malleable iron.

Experiment VI. Thirty-one grains of artificial plumbago, in ſhining flakes from the iron-works, were expoſed, in a ſmall retort, to a ſtrong heat, for ſix hours, in the ſame pneumatic apparatus. It was difficult to ſeparate, even by the help of the magnet, all the intimately-mixed particles of iron; and there were alſo a few particles of coak incorporated with the plumbago. Air, of an exploſive inflammable kind, was extricated, and roſe freely, through five inches of mercury. We had not been ſufficiently careful to let the lute fix before we commenced the experiment, and it ſoon failed. Upon taking off the preſſure of the mercury entirely, and repairing the lute as well as we could, we had every reaſon to believe that the air ſoon ceaſed. The air received in the mercury contained one-eighth of carbonic acid: the remainder exploded. The plumbago loſt four grains. Mr. Pelletier, if I remember right, found that native plumbago, expoſed to a fierce and long continued heat, loſt 10 grains in 200. In the preſent experiment, its appearance was unaltered. Probably the loſs was owing to moiſture imbibed by the

the particles of coak, and to a ſmall combuſtion by the air in the retort.

It will, I think, be admitted, that theſe experiments abundantly confirm the inferences I had formerly drawn, from appearances by their nature leſs deciſive. The real extrication of air, varying in its nature at various periods of the proceſs, ſeems to be placed beyond doubt. The experiments in glazed and glaſs veſſels, were made with a view to exclude the poſſibility of the ſuppoſition of the air entering through the pores. I think that Dr. Prieſtley, if he ſhould repeat theſe experiments, and find that they have been accurately made, will, with his accuſtomed openneſs to conviction, abandon an opinion he has for ſome time entertained, and no longer conſider water as eſſential to the conſtitution of elaſtic fluids. Several obſervations might be made upon this point, and thoſe which I have juſt noticed above; but they will readily occur to perſons converſant in chemiſtry. I ſhall therefore confine myſelf to the unexpected and anomalous appearances, and then attempt to draw a few uſeful inferences.

Firſt. I was ſurpriſed at the extrication of inflammable air in ſuch low degrees of heat. We have ſeen that caſt-iron, highly charged with charcoal, (the *phlogiſto onuſtum* of Bergman,) yields air at the temperature of melting lead. For, undoubtedly, the

the bliſters of lead, which lay upon the iron, are to be conſidered as air-bubbles, caught in a ſolid film of lead. Perhaps white caſt-iron would not yield air ſo readily; poſſibly iron holds its charcoal with more force, as it contains leſs. I intend to make ſome comparative experiments upon the varieties of caſt-iron; but ſo curious an appearance as theſe bliſters, will always be rather the bounty of accident than the effect of ſkill or labour. The obvious method to produce them would be, to cover the iron with lead. All the unmelted lumps of iron were porous, and open in their texture.

Secondly. I am at ſome loſs how to explain the occaſional diſcharge and ceſſation of air, in one experiment, in which a crown-glaſs retort was uſed, and in another, with an unglazed earthen tube. There was no flaw in the lute, nor in the veſſels, for it was diſcharged for the ſpace of ſeveral hours, under a ſmall preſſure. Either, then, it was forced through the ſoftened glaſs in the firſt, and the dilated pores of the tube in the ſecond caſe; or it was abſorbed by the ſubſtance of the veſſels; or it was not extricated from the iron. Of theſe ſuppoſitions, the third ſeems to me the moſt probable. It is not likely that a hole ſhould be made through the melted glaſs, under the preſſure of half an inch, and cloſed under that of per-

haps

haps the eighth of one; or that pores in the tube ſhould open and ſhut in conformity to ſuch a variation of circumſtances; and, with regard to the tube, there can be no queſtion as to abſorption. One principal difficulty, as it appears to me, in the manufacture of iron, is to get rid of the charcoal. The oxygen readily enough unites with a ſmall portion; but the attraction of the iron on the one hand, and, on the other, the little diſpoſition of the charcoal to put on the elaſtic form, in compariſon with many other leſs fixed ſubſtances, together form a very conſiderable obſtacle to the change of charcoal into air; and, as I have already obſerved, the iron probably holds the charcoal more ſtrongly, as its quantity diminiſhes. In this ſtate of things, a ſmall additional impediment will prevent the heat from throwing the charcoal into the ſtate of air; and ſome degree of preſſure muſt be adequate to this effect; and why may not this point (from which as you recede on oppoſite ſides, the attraction of the particles of charcoal for one another, or for iron, either ſhall or ſhall not be overcome by heat,) have been found in theſe experiments? The next conſideration will both illuſtrate and confirm theſe ideas.

Thirdly. A chemiſt whoſe notions of iron are derived principally from books, and from the phænomena which are preſented by proceſſes not having

having metallurgy for their immediate object, will be apt to consider some things related above as inconsistent; the violence of the heat, for instance, and the smallness of its effects; since even cast iron was not fused in all the experiments. The fact is, when cast iron exposes a large surface, and heat is gradually applied, it proves almost as infusible as malleable iron. Indeed, by the gradual action of heat, it is converted, superficially at least, into malleable iron, or approximates towards it; and, considering only iron and charcoal, I believe the fusibility of iron will be directly as the quantity of charcoal it contains. Now, in the experiments I have described, pieces of one, two, and three drachms, and sometimes less, were used, for larger could not be inserted into the neck of the retort. In order to avoid this inconvenience in future, I would recommend cylinders to be cast, of a diameter suited to the mouths of the vessels. This infusible coat would be an impediment to the conversion of the parts below, by pressing upon them: the elastic fluids either could not traverse the solid surface so freely as a liquid, or perhaps, as I am disposed to believe, they could not traverse it at all. The malleable skin seems close in its texture, and the porosity of the rest might arise from the generation of just air enough to produce an internal expansion. In the puddling operation,

operation, it is of the moſt material conſequence to keep the maſs in conſtant agitation. Thus the parts are thoroughly blended, the attraction of coheſion is a good deal counteracted, and there can be no pieces hide-bound, if I may ſo expreſs myſelf. This laſt, perhaps, is the greateſt advantage derived from the labour of the workman.

Fourthly. I was aſked, by one of the moſt ingenious and profound philoſophers of the preſent age, why I had neglected the action of the atmoſpheric air, in the theory of the converſion of iron. It is ſimply becauſe its action upon the metal ſeems, in practice, pernicious. I conſider its preſence as an evil, though a neceſſary one, according to the preſent modes of working. I was alſo anxious to try this opinion by the teſt of experiment, and we ſee it has been fully confirmed. In the laſt experiment, part of the iron was completely converted; and, in ſome others, it ſeemed approaching faſt towards *nature*, as the manufacturers expreſs it. It is indeed very poſſible to conceive a way in which air might be beneficial; that is, if it could be applied ſo as to burn the charcoal merely; but, at preſent, for one grain of charcoal which it converts into carbonic acid air, it converts many of iron into finery cinder; and, as I have formerly ſhewn, this is not the way in which iron is actually converted

verted in the reverberatory, and probably not in the finery furnace.'

Fifthly. It is impoſſible to aſcertain the principles of any art, without immediately improving the practice, or opening a proſpect of future improvement. The preceding obſervations may ſerve to direct attempts to render the metallurgy of iron leſs difficult, laborious, and expenſive. For, firſt, if a quantity of oxygene, nearly ſufficient to burn the charcoal, could be chemically combined with the caſt-iron, the operation would conſume leſs fuel, and would not require ſo long a time. It may be worth while to conſider, if the ores of iron containing mangaueſe, owe any part of their value to this circumſtance. Secondly. If it could be contrived to apply a ſufficient heat to large quantities of iron in cloſe veſſels, and at the ſame time to agitate them ſufficiently, the loſs in converſion would not, perhaps, exceed ten in a hundred. Thirdly. The important object of converting Britiſh iron into ſteel, may poſſibly be attained by following up reflections ſuggeſted by the foregoing experiments. When the oxygene has been ſeparated in the form of carbonic acid, there will remain the charcoal and iron, the conſtituent parts of ſteel. Perhaps the materials, at a certain period of the proceſs, may be ſo nearly approaching to ſteel as to be eaſily con-

 vertible.

vertible. The maſs will contain alſo a quantity of ſulphur, on which perhaps the difficulty of making good ſteel from our iron depends. But this difficulty, I am perſuaded, will not be inſuperable.

It may be proper to add, that whenever attention was paid to it, the hepatic ſmell in the extricated air was perfectly diſtinguiſhable.

I alſo think it right to ſay, that whatever information or advantage may be derived from theſe facts and obſervations, muſt be in a great meaſure aſcribed to the liberal curioſity of William Reynolds, whoſe enterpriſing ſpirit and inventive genius have improved our machinery, enlarged our manufactures, and changed the face of a large diſtrict in his native county.

P. S. The reſiduum of 486 grains of caſt-iron, the ſame as that uſed in experiment I, weighed 48½ grains, after being diſſolved in weak vitriolic acid, and heated to a dull red heat: the ſame quantity of iron, after the experiment, afforded a reſiduum of 39 grains, and a little more. In the reſiduum left by equal quantities of iron, before and after the experiment in the unglazed tube, there was a difference of five grains: the ſolution of the iron that had been ſubmitted to the experiment went on very ſlowly, and would not

not have been effected by vitriolic acid in many months. In the latter case, I used some muriatic acid, which quickly dissolved it: in the former, weak aqua regia was used for the solution of a very small part of the whole lump. I suspected lead to have caused the slowness of the solution in the first case, but there can be no such suspicion in the second. The difference between these residuums tends to shew that plumbago was consumed by the heat, but they do not shew the loss accurately; for, in the residuum of the iron that had been fused in the first experiment, there was a small quantity of vitriolated lead; and in the other there was, besides the plumbago, a small quantity of that difficultly soluble calx of iron, which the solutions of this metal deposit on long exposure to air; the difference was greater, therefore, than it appeared. On the other hand, the long action of the acids might have consumed some plumbago. There was little or no calx attractable by the magnet in the residuum of the fused iron. From the 48 grains of residuum, I separated more than six grains by the magnet.

LII. *Conclusion of Sir* George Shee's *Observations on the Construction of Ships.*

(From Page 345.)

THE improvements then which I beg leave to recommend in the conftruction of merchant-veffels are, an increafe of their horizontal, and a decreafe of their perpendicular dimenfions; which will correct the three defects I have pointed out: alfo the alteration in the fhape of their fides and bows, which I have already faid is neceffary, in order to render thefe improvements practicable.

Were the length of the keel even fo far extended, as that it fhould reach two perpendicular lines dropped from the extreme points of a fhip's upper-deck, the increafe of gripe would be prodigious, and the additional expence trifling. A fheer or projection abaft is unqueftionably beautiful; but it is of no ufe, and the eye would foon become reconciled to an upright ftern. The fheer, however, might be given with any length of keel, where expence fhould be difregarded; unlefs it fhould be thought, which I am rather inclined

inclined to believe, that a very long veſſel would be weakened by it; for the ſtrain upon a ſhip's centre, is in fact reſiſted more by the binding of her upper planks and timbers, than by the ſtrength of her keel. The expence of this increaſe of length would be nearly paid, by the ſaving cauſed by the reduction of her depth.

The alteration in the form of the ſides and bows, needs a few words more of explanation.

The effect to be expected from a flat ſide, is exemplified in an ingenious contrivance, uſed to ſupply want of depth, in Dutch veſſels of various deſcriptions; and I cannot give a more correct idea of the improvement in this reſpect I wiſh to recommend, than by ſaying, that the ſide of a ſhip, below the water-level, or a part of it at leaſt, ought to reſemble a *lee-board*, of conſiderable extent. By means of this board, many Dutch merchant-veſſels, notwithſtanding they are conſtructed with a floor almoſt flat, to fit them for great burden and ſhallow water, are found to ſail tolerably well upon a wind; and yet they are in general ſhort, with bluff upright bows, and many other defects.

Dutch fiſhing-veſſels too, particularly thoſe employed in great numbers on the coaſt of England, are rendered, by the uſe of a lee-board, good ſailers. Not being intended for burden, they do not, in general, much exceed boat-ſize; and,

although

although they are the moſt flat of all decked veſſels, their ſecurity in blowing weather is proverbial.

Now, in reſpect to the bows of merchant-ſhips, I will only obſerve, that although they ſlope off tolerably well when veſſels are light, they preſent, when laden, ſuch reſiſtance to head-way, as can ſcarcely be overcome by any preſſure of ſail. The evident remedy is, to render them leſs upright; expanſion in them, although abſolutely neceſſary above the water-level, being quite uſeleſs below it.

By adopting theſe improvements, I am perſuaded, that the ſame quantity of timber, and other materials, now employed in building a merchant-veſſel of one hundred tons burden, would ſerve to form one capable of carrying at leaſt one hundred and thirty, and that the velocity gained would rather exceed this proportion. The advantage of performing three voyages in the uſual time of two, or even ſuppoſe five in the time of four, need not be ſtated; nor need that which would reſult, in the ſeaſon of tempeſt, from reducing the length of time in which ſhips are expoſed to danger; or, in time of war, from rendering them capable of evading purſuit.

The conſtruction of veſſels employed in carrying mails between Dublin and Holyhead, I conceive to be nearly as defective as that of mer-

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chant-ſhips, which their hulls in a great meaſure reſemble, although they are built expreſſly for ſpeed and accommodation, and not for burden. But indeed they do carry burden; for, from their deep form, they require an abſolute loading of ballaſt, to prevent them from overſetting; and their draught of water is ſuch, although ſmall veſſels, that they can float on the Dublin Bar only at a particular time of tide; by which, fair winds are frequently miſſed, and the paſſage from England unneceſſarily prolonged. From their want of length, and exceſſive depth, they are ſuch ſlow ſailers, that the Favourite, a light long veſſel, fitted out by private individuals, has made her paſſage to Holyhead in nine hours, when two packets, which weighed anchor when ſhe did, took twelve to perform theirs.

In determining the moſt proper conſtruction for theſe, or indeed any other ſea-veſſels, it ſhould be conſidered, that the greater the length, the leſs depth will be neceſſary to prevent lee-way; and that the greater the breadth, the more ſail may be carried, and the leſs ballaſt required. Weight, it is true, does not operate exactly upon ſhips as burden does upon animals; its ſituation, as I have already ſaid, determining in a great meaſure the reſiſtance it cauſes to velocity; but, that its operation is conſiderable, cannot I believe be doubted. In ſhort, I am perſuaded that

packet-

packet-veſſels might be conſtructed on a principle ſo light, that they might paſs the Dublin Bar, at any time of tide, ſo ſpeedily, that they would commonly perform their voyage in three-fourths, or perhaps two-thirds, of the time thoſe in uſe now employ; and, at the ſame time that they would, if poſſible, be more ſafe, and certainly much more commodious, their building and ſailing charges would not be more conſiderable.

To determine the exact extent to which the improvements I recommend can, in general, be practically applied, is not my preſent object. I only mean to ſuggeſt hints, which, if thought deſerving of the trouble, may eaſily be thrown into a regular ſyſtem; and I will cloſe an addreſs, imperceptibly extended beyond its intended limits, with a word on ſhips of war.

If theſe improvements are founded on the true principles of naval architecture, their application may certainly be extended to the conſtruction of frigates, and all other king's ſhips carrying one tier of guns only; but, that thoſe of two and three tier can be improved in an equal degree, is an aſſertion I will not hazard. The effect of the weight the latter carry above water, muſt be counteracted by a proportionate weight below it; and it is poſſible that an increaſe of their horizontal expanſion would be unſafe, conſidering that timber beyond the preſent dimen-

ſions

ſions cannot well be procured. Determinate flatneſs of ſide, however, for ſome diſtance below the ſurface of the water, would aid very conſiderably in reſiſting the effect of a ſide-wind, on ſo prodigious a ſurface as their hulls preſent above water; and even a very trifling addition to their breadth of beam, would probably enable them to carry their guns better than they now do in a high ſea, and render ſome reduction of their draught of water practicable.

That light frigates might be made capable of receiving as great velocity from a moderate breeze, as is now given them by a ſtrong wind, is a truth I am perſuaded of; and, that the utmoſt velocity any veſſels are capable of is not yet attained in the European ſeas, is a fact that will not be doubted by any perſon who credits the well-authenticated accounts given of flying prows. The form of theſe veſſels, it is true, unfits them for any other ſea but that in the latitude of the Ladrone Iſlands, but uſeful hints may notwithſtanding be taken from their conſtruction.

LIII. *Experiments on the comparative Effects of Solutions of Magnesia, of calcareous Earth, and of Alum, in dying Cloths of various Kinds with Madder, &c. By Mr.* VOGLER.

From CRELL'S CHEMICAL ANNALS.

PURE magnesia, properly prepared from Epsom salt, *(Magnesia Vitriolata,)* and thoroughly washed, was thrown gradually into oil of vitriol, into spirit of nitre, and into spirit of salt. Each of these acids quickly dissolved it, (without the assistance of heat,) with effervescence; and the solutions continued clear, until the acid was completely saturated. A portion of the earth then separated, part of which remained suspended on the surface of the liquor, the other part fell to the bottom. None of this appeared capable of being dissolved, either by the addition of more acid, or by the addition of water, or by the application of heat.

Each

Each of the above-mentioned solutions of magnesia was diluted with three times the quantity of pure water. Woollen, silk, linen, and cotton cloths, all which had been first clean scoured, and dried, were then put into these solutions, and left to soak therein for the space of ten or twelve hours. At the end of that time they were taken out, washed in three separate quantities of clean cold water; then wrung out and dried.

I now set over the fire three deep earthen pots, in each of which I put two drachms of madder, and about a pint (from twelve to fourteen ounces) of clean soft water. After they had boiled for a few minutes, I put into one of the decoctions, the pieces or samples of cloth, of different kinds, which had been prepared and soaked in the solution of magnesia made with oil of vitriol. Into another, I put those pieces which had been soaked in the solution made with spirit of nitre; and, into the third, I put those which had been soaked in the solution made with spirit of salt. When these pieces of cloth had boiled therein for the space of seven or eight minutes, (during which time they were frequently turned about and pressed with a stick,) they were taken out of the decoctions, and, after being two or three times wrung out of clean cold water, were dried in the shade. The

wool and silk appeared to be dyed throughout of a bright brown colour; the linen and cotton were of a pale red.

Experiments similar to the above were at the same time made with solutions of calcareous earth, in the vitriolic, nitrous, and marine, acids. The colours communicated to the cloths prepared in those solutions, and afterwards boiled in a decoction of madder, were found to differ very little, or not at all, from those obtained by means of the solutions of magnesia.

In the same manner I found, by repeated experiments, that alum, and the solutions of its earth in the different acids, gave (when used in dying with the decoction of madder) a light brown colour to wool and silk, and a red colour to linen and cotton. But it must be confessed, that these colours were brighter and finer than those produced with the solutions of magnesia, or with those of calcareous earth.

It appears, therefore, from the above and other comparative trials made with solutions of the aluminous, magnesian, and calcareous earths, in dying cloths of different kinds with madder, logwood, brazil-wood, &c. that no advantage is derived from the use of the two last; as alum and its solutions produce finer colours, and consequently

quently may at all times be employed in preference to the others.

It would perhaps have been worth while to have tried, in the ſame manner, the effects produced by ſolutions of barytes or heavy earth, and likewiſe thoſe of manganeſe (when freed from heterogeneous matter) and its calx, in dying cloths of different kinds with the above-mentioned ſubſtances; but, not poſſeſſing a ſufficient quantity of the barytes, and not having had time and opportunity to prepare pure manganeſe and its calx, I have not yet been able to undertake a courſe of experiments on that ſubject.

LIV.

LIV. *Experiments to shew in what Proportion pure Nitrous Acid is capable of dissolving Gold. By M.* Sage.

From the Memoirs of the Academy of Sciences of Paris.

PURE nitrous acid (of forty-nine degrees, according to M. Baumé's areometer *) has scarcely any action upon thin plates of gold; for, three ounces of this acid, having been boiled upon twelve grains of gold, in the form of a very thin plate, until the acid was reduced to about three drachms, the plate of gold was found to have diminished in weight only $\frac{1}{32}$ of a carat.

Three ounces of nitrous acid (of forty-two degrees) dissolved only $\frac{1}{64}$ of a carat of a thin plate of gold.

* To obtain the nitrous acid of this high degree of concentration, I separate it from nitre, by means of vitriolic acid: I then precipitate it by silver, and distil it again several times.

A lump

A lump of gold, from which the silver (amounting to three quarters of the gold) had been separated by quartation, and which had a porous appearance, was boiled in three ounces of nitrous acid, (of forty-two degrees,) till there remained only about three drachms: the gold was found to have diminished $\frac{16}{32}$ of a carat.

Three ounces of nitrous acid (of forty-two degrees) dissolved, of a lump of porous gold weighing twelve grains, only $\frac{2}{32}$ of a carat.

Three ounces of nitrous acid (of forty-two degrees) having been made to boil upon another lump of porous gold, also weighing twelve grains, until the acid was reduced to about three drachms, dissolved only $\frac{3}{64}$ of a carat of the gold.

LV.

LV. *List of Patents for Inventions, &c.*

(Continued from Page 360.)

WILLIAM BIRCH, of Charlotte-ſtreet, in the pariſh of St. George, Bloomſbury, in the county of Middleſex, Eſquire, on behalf of himſelf and of his ſon Richard Comyns Birch, of Calcutta, in the Eaſt Indies, Eſquire; for a method of purifying, refining, and preparing indigo, for the uſe of dyers. Dated Auguſt 11, 1798.

GEORGE DODGSON, of the pariſh of St. Leonard, Shoreditch, in the county of Middleſex, cabinet-maker; for a method of making and conſtructing pumps and engines for raiſing and evacuating water, or other fluids, and for producing power; and is peculiarly adapted for the uſe of ſhips and veſſels. Dated Auguſt 23, 1798.

FRANCISCO RAPOZO, of Liſbon, in the kingdom of Portugal, captain of engineers, in the ſervice of her Moſt Faithful Majeſty; for improvements in the conſtruction of ſteam-engines. Dated Auguſt 29, 1798.

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